JP-2000-310784E

[Title of the Invention] LIQUID CRYSTAL PANEL, COLOR FILTER AND THEIR PRODUCTION

[Abstract]

[Object] To produce a panel of a liquid crystal display device or the like by properly controlling the gap between substrates and rigidity in the pixel part, black matrix part, sealing part or the like, to improve pressure resistance of the display part as a product, and to obtain good display quality, performance and productivity.

[Solving Means] Protruding spacers 6 or spherical spacers 7 comprising an elastic material are formed in the display region and in the region where a seal is to be formed so as to regularly maintain the gap between substrates 101 and 102. In this method, the modulus of elasticity or dispersion density of these spacers is controlled to the optimum. Or, formation or dispersion density of the spacers is varied depending on the objective place. Moreover, the spacers in the display region and the sealing part 5 are produced in one process, and the spacers can be formed in a single process.

[Claims]

[Claim 1] A liquid crystal panel in which a driving circuit part is formed at the vicinity of a display region

on a substrate and a liquid crystal seal part of the display region is formed on the driving circuit part, wherein an elastic spacer is contained in seal resin.

[Claim 2] The liquid crystal panel according to Claim 1, wherein the elastic spacer is resin spacer.

[Claim 3] The liquid crystal panel according to Claim 1 or 2, wherein the elastic spacer is spherical spacer consisting of the same material or the same modulus of elasticity as the resin spacer in the display region.

[Claim 4] The liquid crystal panel according to Claim 3, wherein the spherical spacer has density of 100 number/mm^2 or more.

[Claim 5] The liquid crystal panel according to Claim 1, 2, 3, or 4, wherein the elastic spacer consists of a material having a load of 1 g which is required for 10% press, in case of a sphere having the diameter of 6 μm.

[Claim 6] The liquid crystal panel according to Claim 5, wherein the elastic spacer consists of a material having a load of 0.5 g or less which is required for 10% press, in case of a sphere having the diameter of 6 μm.

[Claim 7] The liquid crystal panel according to Claim 1, 2, 3, or 4, wherein in case of a sphere having the diameter of 6 μm, the elastic spacer is a proportional space of which deformation amount is 0.5 μm or more when applying the load of 1 g to the spacer, and, when the load change is less than

0.25 g, the deformation amount is changed in proportional to the load in the range of 10%.

[Claim 8] The liquid crystal panel according to Claim 6, wherein in case of a sphere having the diameter of 6 μm, the elastic spacer is a proportional space of which deformation amount is 1.0 μm or more when applying the load of 1 g to the spacer, and, when the load change is less than 0.25 g, the deformation amount is changed in proportional to the load in the range of 10%.

[Claim 9] The liquid crystal panel according to Claim 1, 2, 5, 6, 7, or 8, wherein the elastic spacer is a protrusion space formed on at least one substrate.

[Claim 10] The liquid crystal panel according to Claim 9, wherein the protrusion spacer consists of a material having a polarity group.

[Claim 11] The liquid crystal panel according to Claim 9 or 10, wherein the protrusion spacer is an array side protrusion spacer which is formed on an array substrate having the driving circuit part formed thereon.

[Claim 12] The liquid crystal panel according to Claim 11, wherein the array side protrusion spacer is not formed in a portion in which a transistor element of the driving circuit is arranged.

[Claim 13] The liquid crystal panel according to Claim 9, 10, 11, or 12, wherein the protrusion spacer is a light

using protrusion which is formed by patterning photosensitive resin.

[Claim 14] A liquid crystal panel comprising a protrusion spacer consisting of an elastic body for regularly maintaining substrate interval, in a non-pixel part of a display region.

[Claim 15] A liquid crystal panel having a plurality of liquid crystal layer, wherein a protrusion spacer consisting of an elastic body for regularly maintaining a interval between substrates which are opposite to each other through the liquid crystal layers is formed in a non-pixel part of a display region on at least one substrate in the liquid crystal panel on which the plurality of the liquid crystal layer overlap.

[Claim 16] The liquid crystal panel according to Claim 14 or 15, wherein the protrusion spacer is a low density distribution protrusion spacer having density of 20 number/mm^2 or less.

[Claim 17] A liquid crystal panel comprising a protrusion spacer which controls molecular arrangement and consists of an elastic body so as to regularly maintain substrate interval and regularly arrange the liquid crystal molecules in a predetermined location in a pixel of a display region.

[Claim 18] A liquid crystal panel having a plurality of liquid crystal layer, wherein protrusion spacers for

regularly maintaining an interval between substrates which are opposite to each other through the liquid crystal layers, regularly arranging the liquid crystal molecules, and consisting of an elastic body are formed for each layer, in a predetermined location in a pixel of a display region on each substrate of the liquid crystal panel on which the plurality of the liquid crystal layer overlap, and are arranged in a line along a light progressing direction.

[Claim 19] The liquid crystal panel according to Claim 14, 15, 16, 17, or 18, wherein the protrusion spacer is a light using protrusion space formed by patterning photosensitive resin.

[Claim 20] A liquid crystal panel or a color filter comprising a protrusion space for regularly maintaining substrate interval in a display region and a region in which a seal is formed.

[Claim 21] The liquid crystal panel or the color filter according to Claim 20, wherein the protrusion spacer is formed in any one of an array substrate and an opposite substrate.

[Claim 22] The liquid crystal panel or the color filter according to Claim 20 or 21, wherein the protrusion spacer is a same-length protrusion space of which height is equal in the display region and the region in which the seal is formed.

[Claim 23] The liquid crystal panel or the color filter according to Claim 20, 21, or 22, wherein the protrusion spacer has a height controlling film for controlling the height due to the location difference between the display region and the region in which the seal is formed, on at least one of the upper and lower sides.

[Claim 24] The liquid crystal panel or the color filter according to Claim 23, wherein the height controlling film serves as at least one of a conductive film of a pixel part, a reflecting plate, an orientation film, and a color filter.

[Claim 25] The liquid crystal panel or the color filter according to Claim 20, 21, 22, 23, or 24 wherein the spacer is a protrusion spacer consisting of photosensitive resin.

[Claim 26] The liquid crystal panel or the color filter according to Claim 20, 21, 22, 23, 24, or 25, wherein the protrusion spacer is a forming-region considering protrusion spacer which forming density × cross section of bottom of a protrusion formed in the display region is smaller than forming density × cross section of bottom of a protrusion formed in the region in which the seal is formed.

[Claim 27] The liquid crystal panel or the color filter according to Claim 21, 22, 23, 24, 25, or 26, wherein the protrusion spacer a number considering protrusion spacer which the forming density of the display region is in the range of 5 number/mm^2 to 50 number/mm^2 and the forming

density of the region in which the seal is formed is in the range of 10 number/mm^2 to 80 number/mm^2.

[Claim 28] The liquid crystal panel or the color filter according to Claim 21, 22, 23, 24, 25, 26, or 27, wherein the protrusion spacer is a rigid transmitted-light considering spacer which the horizontal cross section of the protrusion in the display region is smaller than that of the protrusion in the region in which the seal is formed.

[Claim 29] The liquid crystal panel or the color filter according to Claim 21, 22, 23, 24, 25, 26, 27, or 28, wherein the protrusion spacer is a specific-range area-ratio protrusion spacer which the ratio of the protrusion formed in the display region to the display region is in the range of 0.05% to 0.5% and the ratio of the protrusion formed in the region in which the seal is formed to the region in which the seal is formed is in 0.1% to 1.0%.

[Claim 30] The liquid crystal panel or the color filter according to Claim 20, 21, 22, 23, 24, 25, 26, 27, 28, or 29, wherein the upper surface area/the lower surface area of the protrusion spacer is in the range 0.2 to 0.9.

[Claim 31] The liquid crystal panel or the color filter according to Claim 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30, wherein the height of the protrusion spacer in the display region is different from that of the protrusion spacer in the region in which the seal is formed.

[Claim 32] A method for manufacturing a liquid crystal panel in which a liquid crystal is interposed between substrates, comprising:

forming protrusion spacers for regularly maintaining substrate interval in a display region and a seal region on at least one substrate;

coating seal resin at the periphery of the display region of at least one substrate, sticking the both substrates, curing the seal resin, and forming an empty panel; and

injecting the liquid crystal into the empty panel.

[Claim 33] A method for manufacturing a liquid crystal panel in which a liquid crystal is interposed between substrates, comprising:

forming protrusion spacers for regularly maintaining substrate interval in a display region and a seal region;

coating seal resin at the periphery of the display region of any one substrate;

dripping the liquid crystal on the substrate coated with the seal resin;

covering the other substrate on the substrate on which the liquid crystal is dripped, while gas is not left therein; and

curing the coated seal resin so that the liquid crystal is adversely influenced and sticking the both substrate.

[Claim 34] The method according to Claim 32 or 33, before

forming the protrusion spacer, further comprising a height controlling film for controlling the height required for the protrusion spacer in the display region and the seal region.

[Claim 35] The method according to Claim 34, wherein the step of forming the height controlling film includes forming at least one of a reflecting film, a conductive film or a color filter.

[Claim 36] The method according to Claim 34, wherein the step of forming the height controlling film includes forming an orientation film, a conductive film or a color filter.

[Claim 37] The method according to Claim 36, after forming the height controlling film and forming the protrusion spacer, further comprising a non-contact orientation processing step for performing an orientation process to an orientation film by ultraviolet rays.

[Claim 38] The method according to Claim 35, 36, or 37, wherein the step of forming the height controlling film includes forming the height controlling film by using resin as a material and spin-coating the resin.

[Claim 39] The method according to Claim 32, 33, 34, 35, 36, 37, or 38, wherein the step of forming the protrusion spacer includes forming a protrusion spacer which serves as a peripheral wall, in a region in which a seal is formed at the periphery of the display region.

[Claim 40] A method for manufacturing a liquid crystal

panel having a liquid crystal layer on a substrate, comprising:

forming a protrusion spacer for regularly maintaining a thickness of the panel and protecting the liquid crystal in a display region on the substrate from a pressing force;

forming a wall-shaped protrusion for contributing to form the liquid crystal layer and surrounding and protecting the liquid crystal layer at the periphery of the display region;

filling the high molecular dispersion type liquid crystal, precursor thereof and resin matrix, or a mixture of the precursor thereof in the wall-shaped protrusion; and

forming the liquid crystal layer which is high molecular dispersion type liquid crystal drop dispersed therein and a matrix of high molecular dispersion type liquid crystal drop by irradiating ultraviolet rays.

[Claim 41] A method for manufacturing a liquid crystal panel having a liquid crystal layer on a substrate, comprising:

forming a protrusion spacer for regularly maintaining a thickness of the panel and protecting the liquid crystal in a display region on the substrate from a pressing force;

forming a wall-shaped protrusion for contributing to form the liquid crystal layer and surrounding and protecting the liquid crystal layer at the periphery of the display region;

filling the high molecular dispersion type liquid crystal,

precursor thereof and resin matrix, or a mixture of the precursor thereof in the wall-shaped protrusion; and

forming the liquid crystal layer formed at the lower side and an upper film which is a transmittance film and is formed at the upper side by irradiating ultraviolet rays.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a color filter of a plasma panel used for image display and a panel used for a liquid crystal display device or an optical shutter, and more particularly, to maintenance of an interval between substrates of a panel.

[0002]

[Description of the Related Art]

Recently, a liquid crystal panel (except parts which are directly related to the display of a display device using a liquid crystal, that is, a CPU, a keyboard, a power supply source or the like) has been widely used for a wristwatch, an electronic calculator, a personal computer, a personal word processor), because it has merits such as thinness, light weight, and low voltage driving.

[0003]

However, in order to regularly maintain the interval

between two substrate on which a liquid crystal or a pixel circuit is formed, spacers are sprayed using N_2 gas, air, or ethanol in a display region of a conventional liquid crystal panel before sticking the two substrates.

[0004]

Moreover, a seal part composed of solidified resin is formed at the outer side of the display region so as to seal the liquid crystal between the substrates, and spacers are mixed in the resin of the seal part so as to regularly maintain the interval before solidification.

[0005]

As the spacers, spherical resin or glass fiber without cylindrical alkali or SiO_2 has been used.

[0006]

If the spacers in the display region are too hard, an array element such as a transistor for driving the pixel on the substrate or a wiring may be damaged when a user applies an external force to the panel for several reasons. Also, in a room temperature, the temperature change of the panel becomes increased in accompanying with the usage of the user, and, in serious case, the spacers can not adequately track the contraction and expansion of the liquid crystal accompanied by the temperature change and foam may be generated therein. Thereby, spherical resin spacers which are similar to the liquid crystal in a property of matter,

particularly, elasticity, thermal expansion, and specific gravity have been generally used instead of SiO_2 or the glass fiber. Also, the density of the resin spacer is about 70-100 number/mm^2.

[0007]

On the other hand, as the spacer in the seal part, glass fiber having a length of 20-120 μm and a diameter of 2-12 μm has been used, because a transistor for driving the liquid crystal need not be formed on an array element, the spacer does not contact with the liquid crystal and exists in the solidified seal resin so that foam accompanied by the thermal contraction and expansion is not generated, the spacer is cheap, the spacer can not be moved before curing the seal resin, the spacer is hardly subjected to the change of the pressing force for regularly maintaining the substrate interval when curing the seal resin due to the rigidity, and the spacer has good adhesive property with seal resin having a polarity (OH group) such as epoxy resin or phenol resin. Also, the density of the glass fiber is about 50-60 number/mm^2.

[0008]

[Problems to be Solved by the Invention]

However, conventionally, as a semiconductor for a transistor for driving a pixel of an active matrix type liquid crystal display device, amorphous silicon was been

used and a circuit for driving the pixel was formed using a TAB (Tape Automated Bonding) method. This is a method for sticking a driving IC on a film and bonding the film to a liquid crystal panel and a print board.

[0009]

Recently, as the semiconductor (material) for the transistor (element), a method using polysilicon having a fast electron moving rate and good response has been actually used.

[0010]

If the polysilicon is used, the circuit for driving the pixel can be formed as a peripheral driving circuit integral with the transistor for the pixel at the periphery of the substrate on which the pixel is formed. At this time, if the peripheral driving circuit is positioned below the seal part for the liquid crystal which is located at the periphery of the display region of two glass substrates on which the liquid crystal or the circuit for the liquid crystal is formed, the size of the substrate can be reduced.

[0011]

An example of the liquid crystal display device is shown in Fig. 1.

[0012]

In Fig. 1, 1 is a substrate. 20 is a display region part having a plurality of pixels which are arranged in a

grid. 21 is a circuit part for driving a gate. 22 is a circuit part for driving a source. 5 is a resin part consisting of seal resin. 9 is a conductive paste. 50 is a sealing part consisting of sealing resin.

[0013]

Also, the width of the seal part is about 1 mm. Further, although the volume change or foam is generated upon solidifying the seal resin, the interval between upper and lower substrates is regularly maintained and the pressing force of $1kg/cm^2$ is applied based on the density of the glass fiber so as to perform good bond between the substrate and the resin.

[0014]

However, if the sphere of glass fiber or SiO_2 is used as the spacer in the seal part as in the prior art, the peripheral driving circuit may be destroyed by the hard glass fiber when the upper and lower substrate are bonded, particularly, when the both substrates are pressurized so as to maintain the substrate interval to a predetermined value, by some reasons such as mistake of an operator when initially setting a pressing tool or vibrations accompanied by the movement of an adjacent large machine or earthquake. Particularly, this danger is important because the element such as the transistor or the wiring as well as the device itself is light-weighted and miniaturized.

[0015]

Moreover, this danger is important in case of an amount of productions can be performed according to the miniaturization, since the pressing force can not be controlled during the time required for completely solidifying the seal resin. Similarly, this danger is particularly important in case of laminating and pressing a plurality of display devices in a vertical direction.

[0016]

Also, as can be seen from Fig. 1, since, at the periphery of the substrate, the conductive paste, a part in which the driving circuit part does not exist, or a bending part exists, the adequate pressing is performed over the entire peripheral driving circuit part.

[0017]

In addition, manufacturing error exists in the diameter of the glass fiber or the thickness of the glass substrate. Also, even in case of having the same thickness error such as 1 μm, since the secondary section moment is inversely proportional to third power of the thickness as the thickness of the substrate is thin, the adverse affection on the pressing force, deformation due to deviation and the deviation of force applied to the element becomes increased. Thereby, the pressing force can not be adequately controlled from this surface.

[0018]

Also, it is difficult that the glass fiber is not arranged at the part in which the element which is apt to be damaged by the pressing force exists.

[0019]

Next, in case of performing color display, for example, a display method using guest/host cell of cyan, magenta, and yellow, that is, a method for using a plurality (3 in principle) of liquid crystal layers has been developed, as shown in Fig. 2(a).

[0020]

Also, in Fig. 2(a), 211, 212, 213, and 214 are a combination of substrate and electrode, and 301, 302, and 303 are liquid crystal and pigment for color. 40 is light.

[0021]

In this case, as shown in Fig. 2(b), the substrate intervals may be different or the intervals between the lowest substrate and the substrate for each color may be different in the display region and the peripheral driving circuit part.

[0022]

In Fig. 2(b), 221, 222, and 223 are peripheral driving circuit part for color pixel, and 224 is a control driving part. Also, 91 is a connection part between the combination of the substrate and electrodes 212, 213, 214 and the

control driving part 224.

[0023]

In this case, if the spacer 19 consisting of the glass fiber is used in the seal part as in the prior art, the diameter of the glass fiber required for the substrate may be different and thus it is not preferable in view of the kind or density distribution of the glass fiber or maintenance of the distance between the support points of glass substrate supported by the spacers.

[0024]

Also, similarly, in this case, if the spherical resin spacers is used for maintaining the interval between the substrates in the display part, the density of the spacer is three times, that is, about (70-100)×3 number/mm^2 of that of the single liquid crystal layer method, and it is not preferable in view of the orientation of the liquid crystal, transmittance or diffusion of the light, and the display quality. In addition, even in the color display method of the signal liquid crystal layer, the miniaturization of the pixel accompanying with the miniaturization of the element is realized under the request of high quality. However, even in this case, it is not preferable that the spherical spacers are located in the display region.

[0025]

This is similar in a double matrix type or multiple

matrix type display device which has been developed for the high density of the pixel.

[0026]

Furthermore, in case of forming the spacers by a dispersion method, the dispersion density may be irregular in the display region. Accordingly, the cell thicknesses of the liquid crystal panel are different in the screen and uneven display may be generated.

[0027]

Moreover, the liquid crystal is injected between the substrate using a vacuum injecting method (a method for providing the empty panel which is sealed except an injecting port in a bath containing the liquid crystal, vacuumizing the inside of the panel, immersing the injecting port in the liquid crystal, and returning the inside of the bath to an atmospheric pressure to inject the liquid crystal into the panel). In this case, since the area which the liquid crystal is introduced into the panel, the injecting time is long, and the liquid crystal is rapidly injected into the panel at the beginning of the injection, the liquid crystal is apt to be influenced by the spacer and thus uneven orientation is apt to be generated upon the injection. Also, the distribution of the spacers may be influenced.

[0028]

In addition, the required rigidity is different in the

display part of the panel center and the part for sealing the liquid crystal layer of the substrate end. However, this can not be solved only by dispersing the spherical glass spacer. Also, separately dispersing the glass fiber and the glass sphere in the seal part and the display part is troublesome and causes various problems.

[0029]

Moreover, the rigidity required for the panel, particularly, the seal material and the substrate interval is different by the usage, the shape, or the dimension of the liquid crystal display device. If the glass fiber is previously mixed in the seal resin, adequate seal mixing resin must be manufactured one by one.

[0030]

In order to solve the problems, a method for forming cylindrical spacers (Japanese Unexamined Patent Application Publication No. 9-73093 and Japanese Unexamined Patent Application Publication No. 10-68955) is suggested. However, in these methods, the cylindrical spacers are formed in the display region and are not formed in the seal part.

[0031]

Furthermore, in Japanese Unexamined Patent Application Publication No. 9-49916, a method for forming spacers by laminating color layers of three primary colors in a region corresponding to the seal part and the matrix in the display

region is suggested. However, in this method, since the height (size) of the color layer must be changed so as to change the cell thickness, the color purity is also changed. In addition, since the spacer are formed the lamination, the overlap precision of the lamination is required and thus the spacers having large sizes must be formed.

[0032]

Also, in Japanese Unexamined Patent Application Publication No. 7-281195, a method for forming spacers by protrusions formed using a method of laminating color layer on a color filter substrate and a black matrix formed on an array substrate is suggested. However, this method has the same problem as Japanese Unexamined Patent Application Publication No. 9-49916. That is, since the spacers are formed by the overlap of the array substrate and the color filter substrate, there is a problem in the overlap precision and thus the spacers must be manufactured with large sizes.

[0033]

Thereby, in the liquid crystal panel in which the peripheral driving circuit is formed below the seal part of the liquid crystal of the display region on the substrate using the polysilicon, the development of a seal technology for preventing the peripheral driving circuit from being damaged while regularly maintaining the substrate interval

is required.

[0034]

Moreover, when filling the liquid crystal between the substrates, the development of a technology for maintaining the substrate interval without problems is required.

[0035]

Also, the development of a seal technology having adequate rigidity depending on the usage, shape, and the dimension of the panel is required.

[0036]

In a color display type panel having a plurality of liquid crystal layers without a color filter, the development of a technology for maintaining the adequate substrate interval while completely sealing the peripheral part is required.

[0037]

Furthermore, in a liquid crystal panel having high performance and a small size, particularly, a panel having a plurality of liquid crystal layers, the development of the spacer which does not generate orientation of the liquid crystal or the diffusion of the light in the display region is required.

[0038]

In addition, in a method for simultaneously forming a liquid crystal layer and a transparent resin film or a

display device using a high molecule dispersion liquid crystal, the development of a technology for ensuring or protecting adequate thickness of the transparent resin film and the liquid crystal layer and the dispersed liquid crystal or the matrix is required.

[0039]

In addition, in the liquid crystal panel, a viewing angle must be widened, discretion (line) must be prevented from being generated, and a fast response must be obtained.

[0040]

Although the above-mentioned problems are related to the liquid crystal display device, the similar problem must be solved in an optical shutter using the liquid crystal and the color filter of a projection display and the other plasma display.

[0041]

That is, in case of the plasma display, in order to hold a specific gas in the pixel part of the emission surface or improve the color display characteristic, a color filter is provided at a predetermined distance from the front of the display. However, in order to hold the interval between two substrates with high precision, the above-mentioned problems are generated.

[0042]

Also, the structure of the plasma display using this

liquid crystal will be illustrated in the final part of the embodiments of the present invention.

[0043]

[Means for Solving the Problems]

The present invention is to solve the above-mentioned problems and employs resin spacers having a specific property in a seal resin.

[0044]

Further, a protrusion for maintaining the substrate interval is formed on the substrate of seal part at a regular interval.

[0045]

Also, research into the dispersion density of the resin spacer or density and the forming location of the protrusion is concentrated.

[0046]

Also, similar to the seal part, a protrusion for regularly maintaining the substrate interval is formed in the display region, and research into the shape or the dimension according to the forming location is concentrated.

[0047]

Moreover, research into the formation of the liquid crystal layer or the injection and the filling of the liquid crystal into the liquid crystal panel is concentrated. At this time, air is prevented from being mixed in the liquid

crystal.

[0049]

In addition, the simplification of the manufacturing process and the convenience of the material preparation are considered.

[0050]

Concretely, the present invention has the below-mentioned structure.

[0051]

According to Claim 1, in a liquid crystal panel using a small-sized transistor (element) having high performance which is manufactured using a semiconductor (material) having high performance such as polysilicon, a driving circuit part is formed at the vicinity of a display region on a substrate, a liquid crystal seal part of the display region is formed on the driving circuit part, and an elastic spacer is contained in seal resin of the liquid crystal.

[0052]

By the above-mentioned structure, the following operation is accomplished.

[0053]

In the liquid crystal panel in which a driving circuit part is formed at the vicinity of a display region on a substrate and a liquid crystal seal part of the display region is formed on the driving circuit part, since the

elastic spacer consisting of a material (organic material) except for a glass wool or SiO_2 is previously mixed in the seal resin of the liquid crystal before the solidification or is dispersed before the coating, the elastic spacer is formed as the spacer for maintaining the substrate interval of the seal after solidifying the resin.

[0054]

Also, if necessary, the panel may have a polarization plate, a reflecting plate, and a power supply source.

[0055]

According to Claim 2, the elastic spacer is a polymerizable organic material which is not melt in a temperature which is exposed when the liquid crystal panel is manufactured, for example, 220 °C or more, for example, a petroleum resin which is manufactured using a metallocene catalyst, particularly, a constrained geometry catalyst to have a specific mechanical and physical property, a Teflon resin, or nylon resin.

[0056]

By the above-mentioned structure, the following operation is accomplished.

[0057]

As the elastic spacer, a material which is easily manufactured and has an adequate elasticity value is selected.

[0058]

According to Claim 3, the elastic spacer is spherical spacer consisting of the same material or the same modulus of elasticity as the resin spacer in the display region.

[0059]

By the above-mentioned structure, the following operation is accomplished.

[0060]

The elastic spacer is a spherical spacer consisting of the substantially same (difference of 10%) material and the same modulus of elasticity.

[0061]

Since the spacer is changed depending on the irregularities formed in the substrate surface even in case that the seal resin is not cured, it is prevented from being moved in the substrate surface.

[0062]

According to Claim 4, the spherical spacers having diameters of 6 μm (4- 10 μm) are dispersed with density of 100 number/mm^2 or more, and preferably, 200 number/mm^2.

[0063]

By the above-mentioned structure, the following operation is accomplished.

[0064]

Since the number of the spherical spacers is large, the

pressing force applied to each spacer is dispersed and the error of the diameter of the spacer due to the manufacturing technology can be compensated together with the elastic deformation.

[0065]

Also, the uniformity of the pressing force upon curing the resin is easily ensured. In addition, the substrate having a regular interval is easily manufactured.

[0066]

If the diameter of the resin is large, the number (density) is reduced. That is, the number of the spacer is inversely proportional to the diameter or the square of the diameter of the resin.

[0067]

According to Claim 5, the elastic spacer consists of a material having a load of 1 g which is required for 10% press, in case of a sphere having the diameter of 6 μm.

[0068]

By the above-mentioned structure, the following operation is accomplished.

[0069]

The elastic spacer consists of a material having a load of 1 g which is required for 10% press, in case of a sphere having the diameter of 6 μm so that the transistor is not destroyed by an excessive pressing force upon curing the

seal resin.

[0070]

Accordingly, if the diameter is different, whether the elasticity is equal to the material of the present claim is converted from the hertz curve or the spherical elastic contact theory. The spacer is to maintain the substrate interval of the liquid crystal display device, and, since the substrate interval is several times of 6 μm, the diameter is 10-2 μm although the diameter is different. Accordingly, the elasticity value is not largely changed.

[0071]

Also, although the spacer has the other shape, the material having the same modulus of the elasticity is selected.

[0072]

Moreover, in consideration of the contraction which is determined by the pressing force (kg/cm^2) and distribution density ($number/mm^2$) of the resin, the spacer having an adequate diameter is selected.

[0073]

According to Claim 6, the elastic spacer consists of a material having a load of 0.5 g or less which is required for 10% press, in case of a sphere having the diameter of 6 μm.

[0074]

By the above-mentioned structure, the following operation is accomplished.

[0075]

Since the elastic spacer consists of a material having a load of 0.5 g or less which is required for 10% press, in case of a sphere having the diameter of 6 μm, it is more difficult to destroy the transistor.

[0076]

Moreover, since the spacer is adequately changed by the irregularities of the array composed of the semiconductor of the pixel part and the wiring, it is prevented from being moved even when the seal resin is not cured.

[0077]

Also, the irregularities of the spacer diameter do not cause the problems, because the spacers are dispersed with density of 100 number/mm^2.

[0078]

According to Claim 7, in case of a sphere having the diameter of 6 μm, the elastic spacer is a proportional space of which deformation amount is 0.5 μm or more when applying the load of 1 g to the spacer, and, when the load change is less than 0.25 g, the deformation amount is changed in proportional to the load in the range of 10%.

[0079]

By the above-mentioned structure, the following

operation is accomplished.

[0080]

In case of a sphere having the diameter of 6 μm, the elastic spacer is a proportional space of which deformation amount is 0.5 μm or more when applying the load of 1 g to the spacer, and, when the load change is less than 0.25 g, the deformation amount is changed in proportional to the load in the range of 10%.

[0081]

According to Claim 8, in case of a sphere having the diameter of 6 μm, the elastic spacer is a proportional space of which deformation amount is 1.0 μm or more when applying the load of 1 g to the spacer, and, when the load change is less than 0.25 g, the deformation amount is changed in proportional to the load in the range of 10%.

[0082]

By the above-mentioned structure, the following operation is accomplished.

[0083]

In case of a sphere having the diameter of 6 μm, the elastic spacer is a proportional space of which deformation amount is 1.0 μm or more when applying the load of 1 g to the spacer, and, when the load change is less than 0.25 g, the deformation amount is changed in proportional to the load in the range of 10%.

[0084]

According to Claim 9, the elastic spacer is a cylindrical or semi-conical protrusion space formed on at least one substrate, particularly, an array substrate.

[0085]

By the above-mentioned structure, the following operation is accomplished.

[0086]

The elastic spacer is a cylindrical or semi-conical protrusion space formed on at least one substrate. Thereby, the spacer is fixed to the substrate by van der Waals force without coating an adhesive, when vacuum-filling the liquid crystal into the liquid crystal panel and curing the resin of the seal part.

[0087]

According to Claim 10, the elastic spacer consists of a material having a polarity group such as OH or NH_3.

[0088]

By the above-mentioned structure, the following operation is accomplished.

[0089]

Although the elastic spacer uses the seal resin having a polarization group based on the request that the volume change is small upon curing the seal material, the spacer is a cylindrical spacer consisting of a material a polarity

congenial to the resin.

[0090]

In this case, since the spacer has a cylindrical shape and the substrate has irregularities, the space is not moved before curing the seal resin.

[0091]

According to Claim 11, the protrusion spacer is an array side protrusion spacer which is formed on an array substrate having the driving circuit part formed thereon.

[0092]

By the above-mentioned structure, the following operation is accomplished.

[0093]

The protrusion spacer is an array side protrusion spacer which is formed on an array substrate having the driving circuit part formed thereon in consideration of the location. Thereby, the upper substrate is easily provided after coating the seal.

[0094]

Also, since the array substrate is subjected to multiple processes, the protrusion spacer is also controlled in the processes. Thus, the work is not complicated.

[0095]

According to Claim 12, the array side protrusion spacer is not formed in a portion in which a transistor element of

the driving circuit is arranged.

[0096]

By the above-mentioned structure, the following operation is accomplished.

[0097]

The array side protrusion spacer is not formed in a portion in which a transistor element of the driving circuit is arranged.

[0098]

According to Claim 13, the protrusion spacer is a light using protrusion which is formed by patterning photosensitive resin.

[0099]

By the above-mentioned structure, the following operation is accomplished.

[0100]

The protrusion spacer is a light using protrusion which is formed by patterning photosensitive resin in consideration of the location of the transistor. Further, the precision of the location or the productivity is excellent.

[0101]

According to Claim 14, a protrusion spacer consisting of an elastic body for regularly maintaining the substrate interval is formed in a non-pixel part of a display region.

[0102]

By the above-mentioned structure, the following operation is accomplished.

[0103]

A protrusion spacer consisting of an elastic body for regularly maintaining the substrate interval is formed in a non-pixel part of a display region. Thus, the substrate interval is prevented from being changed due to the variation of the gravity and temperature or the expansion of the resin when curing the seal resin.

[0104]

According to Claim 15, a protrusion spacer consisting of an elastic body for regularly maintaining a interval between substrates which are opposite to each other through the liquid crystal layers is formed in a non-pixel part of a display region on at least one substrate in the liquid crystal panel on which the plurality of the liquid crystal layer overlap.

[0105]

By the above-mentioned structure, the following operation is accomplished.

[0106]

The protrusion spacer consisting of an elastic body for regularly maintaining a interval between substrates which are opposite to each other through the liquid crystal layers

is formed in a non-pixel part of a display region on at least one substrate in the liquid crystal panel on which the plurality of the liquid crystal layer overlap.

[0107]

According to Claim 16, the protrusion spacer is a low density distribution protrusion spacer having density of 20 number/mm^2 or less.

[0108]

By the above-mentioned structure, the following operation is accomplished.

[0109]

The protrusion spacer is a low density distribution protrusion spacer having density of 20 number/mm^2 or less, and preferably 10 number/mm^2. Thereby, the liquid crystal is smoothly injected between two substrates and the spacer is apt to follow the temperature change.

[0110]

According to Claim 17, a protrusion spacer which controls molecular arrangement and consists of an elastic body so as to regularly maintain substrate interval and regularly arrange the liquid crystal molecules is formed in a predetermined location in a pixel of a display region.

[0111]

By the above-mentioned structure, the following operation is accomplished.

[0112]

The protrusion spacer which controls molecular arrangement and consists of an elastic body so as to regularly maintain substrate interval and regularly arrange the liquid crystal molecules is formed in a predetermined location in a pixel of a display region. Thereby, the magnification of the viewing angle of the display device or the liquid crystal, the uniformity of the image due to the uniformity of the discretion (line), and the improvement of the characteristics of the liquid crystal of MVA mode or OCB mode are accomplished.

[0113]

Also, by the above-mentioned reason, the top part of the spacer is fixed to the upper (lower) substrate in manufacturing the liquid crystal panel and thus the swell of the substrate of the pixel part is prevented.

[0114]

According to Claim 18, protrusion spacers for regularly maintaining an interval between substrates which are opposite to each other through the liquid crystal layers, regularly arranging the liquid crystal molecules, and consisting of an elastic body are formed for each layer, in a predetermined location in a pixel of a display region on each substrate of the liquid crystal panel on which the plurality of the liquid crystal layer overlap, and are

arranged in a line along a light progressing direction.

[0115]

By the above-mentioned structure, the following operation is accomplished.

[0116]

The protrusion spacers for regularly maintaining an interval between substrates which are opposite to each other through the liquid crystal layers, regularly arranging the liquid crystal molecules, and consisting of an elastic body are formed for each layer, in a predetermined location in a pixel of a display region on each substrate of the liquid crystal panel on which the plurality of the liquid crystal layer overlap, such as double lamination type matrix or GH cell, and are arranged in a line along a light progressing direction.

[0117]

Thereby, the same operation as Claim 16 is accomplished. Also, since the protrusion spacers share a projection surface occupied in a light progressing direction, the light transmissivity is improved.

[0118]

At this time, since the pixel part and the driving circuit part has the same arrangement of TFT (except for the connection part), the common mask of the photolithography used for forming the protrusion spacer may be used.

[0119]

According to Claim 19, the protrusion spacer is a light using protrusion space formed by patterning photosensitive resin.

[0120]

By the above-mentioned structure, the following operation is accomplished.

[0121]

Since the protrusion spacer is a light using protrusion space formed by patterning photosensitive resin in consideration of the location of the transistor, the location precision is good and the spacer is easily formed.

[0122]

According to Claim 20, a protrusion space for regularly maintaining substrate interval in a display region and a region in which a seal is formed.

[0123]

By the above-mentioned structure, the uniform cell thickness from the center of the display part to the display region at the vicinity of the seal can be obtained. Also, the spacers of the display region and the seal part can be formed by one process, the process number and the material can be reduced.

[0124]

Also, since the spacer is the elastic body, the element

such as the liquid crystal display device is not damaged although the pressing error is generated upon the manufacture.

[0125]

Also, a polarization plate adhering step, an orientation film rubbing step, a reflection preventing film forming step, a coating step, an assembling step, and an examining step may be included.

[0126]

According to Claim 21, the protrusion spacer is formed in any one of an array substrate and an opposite substrate.

[0127]

By forming the spacer on the array substrate, the protrusion spacer can be formed together with the array manufacturing process. Thereby, the spacer can be easily formed in a portion except for the center of the pixel part and the semiconductor forming part, in the black matrix or the center of the pixel part so as to widen the viewing angle. On the other hand, by forming the spacer on the opposite substrate, the spacer can be formed when the arrangement of the element of the array substrate can not be changed due to the change of used multiple masks or the spacer can not be formed on the array substrate since various elements are arranged on the array substrate.

[0128]

Also, by forming the spacers on the both substrate, the different materials can be formed in the display unit and the seal part, respectively. Thus, optimal rigidity of the panel and display characteristic can be obtained.

[0129]

Also, since the liquid crystal panel or the color is smoothly arranged on the both substrates, the substrate becomes strong.

[0130]

According to Claim 22, the protrusion spacers are same-length protrusion spaces of which heights are equal in the display region and the region in which the seal is formed.

[0131]

By this structure, the protrusion spacers are formed by one process.

[0132]

According to Claim 23, the protrusion spacer has a height controlling film for controlling the height due to the location difference between the display region and the region in which the seal is formed, on at least one of the upper and lower sides.

[0133]

By the above-mentioned structure, the following operation is accomplished.

[0134]

If the height controlling film is formed when forming the insulating layer and the orientation film, the heights of the protrusion spacers are equal and the protrusion spacers are formed by one process. Also, even in case that irregularities exist in the substrate, since the height controlling film is formed, the uniform cell thickness can be ensured.

[0135]

According to Claim 24, the height controlling film serves as at least one of a conductive film of a pixel part, a reflecting plate, an orientation film, and a color filter.

[0136]

By the above-mentioned structure, the following operation is accomplished.

[0137]

A thin transparent resin film is formed on the array substrate by a spin coating method. The protrusion spacer for maintaining the substrate interval is formed and orientation information is applied to the orientation film by irradiating the ultraviolet rays. Also, the film may be the color filter.

[0138]

According to Claim 25, the spacer is a protrusion spacer consisting of photosensitive resin.

[0139]

By this structure, a plurality of the protrusion spacers can be formed in a predetermined array by a simple photolithographic method.

[0140]

According to Claim 26, the protrusion spacer is a forming-region considering protrusion spacer which forming density × cross section of bottom of a protrusion formed in the display region is smaller than forming density × cross section of bottom of a protrusion formed in the region in which the seal is formed.

[0141]

By this structure, the seal part is strongly fixed and the distortion of the panel is reduced. Also, the good display can be obtained.

[0142]

According to Claim 27, the protrusion spacer a number considering protrusion spacer which the forming density of the display region is in the range of 5 number/mm^2 to 50 number/mm^2, and preferably, 7 number/mm^2 to 15 number/mm^2,and the forming density of the region in which the seal is formed is in the range of 10 number/mm^2 to 80 number/mm^2, and preferably, 30 number/mm^2 to 50 number/mm^2.

[0143]

By this structure, the panel is strongly fixed by the protrusion in the seal part and thus the distortion of the

panel can be suppressed. Also, in the display region, since the number of the spacers is small, the spacer can adequately follow the temperature change.

[0144]

Here, the dimension of the display region 48 (×2-1/2) cm angle and the dimension of the pixel is 0.3(×2-1/2) μm angle. The dimensions may be changed.

According to Claim 28, the protrusion spacer is a rigid transmitted-light considering spacer which the horizontal cross section of the protrusion in the display region is smaller than that of the protrusion in the region in which the seal is formed.

[0145]

By this structure, the seal part is strongly fixed and the distortion of the panel is reduced. On the other hand, the good display can be obtained.

[0146]

According to Claim 29, the protrusion spacer is a specific-range area-ratio protrusion spacer which the ratio of the protrusion formed in the display region to the display region is in the range of 0.05% to 0.5%, and preferably, 0.07% to 0.3%, and the ratio of the protrusion formed in the region in which the seal is formed to the region in which the seal is formed is in 0.1% to 1.0%, and preferably, 0.3% to 0.8%.

[0147]

By this structure, the panel is strongly fixed by the protrusion in the seal part and thus the distortion of the panel can be suppressed. Also, in the display region, since the number of the spacers is small, the spacer can adequately follow the temperature change.

[0148]

Here, the dimension of the display region 48 (×2-1/2) cm angle and the dimension of the pixel is 0.3(×2-1/2) μm angle. The dimensions may be changed.

According to Claim 30, the upper surface area/the lower surface area of the protrusion spacer is in the range 0.2 to 0.9.

[0149]

By this structure, since the orientation confusion due to the protrusion can be reduced and the stable protrusions can be formed, the good display can be obtained.

Here, the dimension of the display region 48 (×2-1/2) cm angle and the dimension of the pixel is 0.3(×2-1/2) μm angle. The dimensions may be changed.

Also, in case that the protrusion spacers are also formed on the opposite substrate, it is preferable that the spacers are formed in a cylindrical shape having the same cross section.

[0150]

According to Claim 31, the height of the protrusion spacer in the display region is different from that of the protrusion spacer in the region in which the seal is formed.

[0151]

According to Claim 32, there is provided a method for manufacturing a liquid crystal panel in which a liquid crystal is interposed between substrates, comprising: forming protrusion spacers for regularly maintaining substrate interval in a display region and a seal region on at least one substrate; coating seal resin at the periphery of the display region of at least one substrate, sticking the both substrates, curing the seal resin, and forming an empty panel; and injecting the liquid crystal into the empty panel.

[0152]

By this structure, the protrusion spacer formed on the substrate is not moved when injecting the liquid crystal, unlike the glass spacer. Accordingly, the display characteristic of the liquid crystal is improved.

[0153]

According to Claim 33, there is provided a method for manufacturing a liquid crystal panel in which a liquid crystal is interposed between substrates, comprising: forming protrusion spacers for regularly maintaining substrate interval in a display region and a seal region;

coating seal resin at the periphery of the display region of any one substrate; dripping the liquid crystal on the substrate coated with the seal resin; covering the other substrate on the substrate on which the liquid crystal is dripped, while gas is not left therein; and curing the coated seal resin so that the liquid crystal is adversely influenced and sticking the both substrate.

[0154]

By this structure, the danger that the impurities of the protrusion spacer are melt in the liquid crystal is reduced.

[0155]

Also, unlike the vacuum injection, the process for curing the resin on the liquid crystal injecting port is not needed.

[0156]

Also, it is preferable that the covering step is a vacuum and a high temperature in view of the fluidity of the liquid crystal and the discharge of the gas contained in the liquid crystal.

[0157]

According to Claim 34, in the method according to Claim 32 or 33, before forming the protrusion spacer, a height controlling film for controlling the height required for the protrusion spacer in the display region and the seal region

is further comprised.

[0158]

By this structure, the protrusion spacer is formed at least one process with respect to one substrate.

[0159]

According to Claim 35, the step of forming the height controlling film includes forming at least one of a reflecting film, a conductive film or a color filter.

[0160]

By this structure, since the color filter becomes or is close to a highest layer of the substrate, the height of the protrusion spacer is short and regular. Also, the combination of the processes is possible.

[0161]

According to Claim 36, the step of forming the height controlling film includes forming an orientation film, a conductive film or a color filter.

[0162]

By this structure, since the height controlling film is formed on the substrate, the protrusion spacer can be formed on the surface of the liquid crystal side.

[0163]

According to Claim 37, after forming the height controlling film and forming the protrusion spacer, a non-contact orientation processing step for performing an

orientation process to an orientation film by ultraviolet rays is further comprised.

[0164]

By this structure, the orientation process can be performed without being adversely influenced by the cylindrical protrusion spacer. Also, the contact type process such as rubbing may be performed.

[0165]

According to Claim 38, the step of forming the height controlling film includes forming the height controlling film by using resin as a material and spin-coating the resin.

[0166]

By this structure, since the irregularities of the substrate are removed, the impurities or air which is left in the irregularities are not mixed in the liquid crystal.

[0167]

According to Claim 39, the step of forming the protrusion spacer includes forming a protrusion spacer which serves as a peripheral wall, in a region in which a seal is formed at the periphery of the display region.

[0168]

By this structure, before sticking the upper and lower substrates, the liquid crystal is filled in the protrusion spacer which serves as the peripheral wall and a liquid crystal display device using a specific type liquid crystal

can be easily manufactured.

[0169]

At this time, the seal resin may be coated on only the periphery of the protrusion spacer. Thereby, the liquid crystal does not contact with the non-cured seal resin.

[0170]

In this case, the top part of the protrusion spacer and the upper substrate are stuck to each other at a high temperature and a vacuum by a van der Waals force. Also, if the ensure adhesion must be performed, thin seal resin may be coated on only the outer half of the top part.

[0171]

According to Claim 40, a protrusion spacer for regularly maintaining a thickness of the panel and protecting the liquid crystal is formed in a display region on the substrate from a pressing force; a wall-shaped protrusion for contributing to form the liquid crystal layer and surrounding and protecting the liquid crystal layer is formed at the periphery of the display region; the high molecular dispersion type liquid crystal, precursor thereof and resin matrix, or a mixture of the precursor thereof is filled in the wall-shaped protrusion; and the liquid crystal layer which is high molecular dispersion type liquid crystal drop dispersed therein and a matrix of high molecular dispersion type liquid crystal drop by irradiating

ultraviolet rays.

[0172]

By this structure, the thickness of the liquid crystal layer is regularly maintained and the liquid crystal layer is protected from the pressing force from the display part or the stress from the outside.

[0173]

In addition, if necessary, the upper panel may be adhered.

[0174]

According to Claim 41, there is provided a liquid crystal panel using mixture of the liquid crystal and the resin which becomes the transparent panel, while there is provided a liquid crystal using a high molecular dispersion type liquid crystal in Claim 39.

[0175]

By this structure, the lower substrate and the upper substrate are simultaneously formed by the upper liquid crystal layer and the transparent or colored transmittance panel.

[0176]

[Description of the Embodiments]

Hereinafter, embodiments of the present invention will be described.

[0177]

(First Embodiment)

Fig. 3 is a cross-sectional view of a main part of a liquid crystal panel according to a first embodiment of the present invention. Fig. 3(a) illustrates the structure of a display region and Fig. 3(b) illustrates the structure of a peripheral driving circuit part.

[0178]

Hereinafter, although the present embodiment will be described with reference to the drawings, a method for forming a pixel electrode and a semiconductor layer as a switching element for driving the pixel electrode will be first described.

[0179]

In a pixel transistor in the display region shown in Fig. 3(a), a image signal line (source) 10 and a scan signal line (gate) 12 are formed on a glass substrate 101 in a matrix (grid) as a metal wiring, and a semiconductor layer (TFT) 14 is formed at the intersection thereof as an active element (switching element). A pixel electrode 201 is formed of a transparent conductive film (ITO), and is connected with the semiconductor layer 14 through a drain 11. When a voltage is applied to the gate, current flows between the source and drain. Also, the semiconductor layer and the gate is covered with an insulating film 13 such as SiO_2 for protection, and the source and the drain are covered with an

insulating film 15 such as SiNx for protection.

[0180]

Next, a transparent conductive film (ITO film) is formed on a glass substrate 102 in correspondence with the conductive film 201 of an array substrate, an orientation film 4 (AL5417: JSR) is then printed on the both substrates 101 and 102, and a rubbing process is performed.

[0181]

Next, the peripheral driving circuit part shown in Fig. 3(b) comprises a circuit for driving the gate and a circuit for driving the source. These comprise a shift register, a buffer, and an analog switch. The same transistor (element) as the pixel part is formed of arrays 11-14 composed of the wiring.

[0182]

The printing and the rubbing of the orientation film may be performed using the other method according to convenience of the manufacture.

[0183]

Next, as shown in Fig. 1, seal resin 5 (struct bond: Mitsuidoatsu) having a width of 1 mm is printed (coated) on the periphery of the glass substrate 1. At this time, resin spacers 7 having a diameter 6 μm is previously mixed in the seal resin so as to regularly maintain the substrate interval. Also, it is preferable that the spacer density is

200-240 per the seal part of 1 mm^2 in view of the adequate press and the seal property. Further, in this case, since the spacers are spherical, the spacers do not overlap unlike the glass fiber. Also, the spacers are apt to be mixed in the seal resin.

[0184]

Thereafter, in order to regularly maintain the substrate interval of the display region, as shown in Fig. 3(a), resin spheres (Epostar GP-HC: Japanese shokubai) having a diameter 6.5 μm is dispersed as spacers 71 in this region. Also, the diameter of the spacer is larger than that of the seal part by 0.5 μm, and the difference of 0.5 μm corresponds to the contraction of the spacer of the seal part upon pressing process and the difference of the thickness of the array. Also, the spacers of the seal part are not spherical, but the deformation thereof is minute. Thus, the spacers of the seal part are not shown. This is similar in the other embodiments.

[0185]

Furthermore, as shown in Fig. 1, the conductive paste 9 is coated at four locations of the lower substrate so that the lower array substrate on which the element is formed and the upper opposite substrate are conductively connected.

[0186]

Thereafter, the substrate 101 and the opposite

substrate 102 shown in Fig. 3 are stuck to each other so that the electrode surfaces are opposite to each other and the seal resin 5 is cured at a temperature of 150 °C for 2 hours.

[0187]

A liquid crystal 3 is injected into the empty panel manufactured by the above-mentioned method using a vacuum injecting method (the empty panel is mounted in a liquid crystal bath, the inside of the bath is vacuumized, a panel injecting port is brought into contact with the liquid crystal, the inside of the bath is returned to an atmospheric pressure to inject the liquid crystal into the panel). Also, at this time, since the both ends of the spherical resin of the pixel part are crushed by the pressing force and the spherical resin is the same organic material as the orientation film of the inner surface of the glass substrate, the contact property is good. Also, since the injection is performed in vacuum, the contact property more increases.

[0188]

Thereafter, optical curing resin (Rock tait 352A) is coated the entire injecting port of the liquid crystal panel as a seal resin 31 and the light is irradiated to this resin for 5 minutes to cure and seal the resin.

[0189]

Also, a polarization plate (not shown) is adhered to the upper and lower sides of the panel (outsides of the glass substrate).

[0190]

In the present embodiment, for comparison, six kinds of the spacers were used as described below.

[0191]

Number	Product Name	Maker	material
A	glass fiber	Japanese electric glass	glass
B	resin sphere	Shokubai Kasei	SiO_2
C	improved B	Shokubai Kasei	SiO_2
D	Microful	Sekisui Finechemical	resin
E	improved D	Sekisui Finechemical	resin
E	Epostar	Japanese shokubai	resin

Further, the both substrate are pressurized so as to prevent the substrate interval from being changed due to the expansion, the deformation, and the foam generation of the resin upon curing the seal resin and preferably stick the resin and substrate to each other. Also, in odder to test the effect of the present invention, the pressing force was 2 kg/cm^2, which is two times of a general case.

[0192]

At the result of observing the seal part of the liquid crystal panel manufactured using these spacers using a microscope, in the liquid crystal panel having the seal

resin in which the spacer A (glass fiber) and spacer B (SiO_2) is mixed, scratch was generated in the driving circuit part below the seal part. Thus, if the liquid crystal panel operates, point defect or line defect was generated.

[0193]

Furthermore, even in the spacer C (improved B), scratch was generated. On the contrary, in the spacers D, E, and F (resin spacer), the scratch was not generated in the driving circuit part below the seal part and thus good display is accomplished.

[0194]

The deformation amounts when a load is applied to these spacers are shown in Fig. 4.

[0195]

That is, since the glass substrate has rigidity higher than that of the resin, it is preferable to the spacers C, D, E, and F of which a pressing load required for pressing the spacer in the seal by 10% in the state that the spacer is interposed between the pressing metal parts (rigid body) of a press deformation tester is 1 g or less (here, since the diameter of the spacer is 6 μm, the deformation amount 0.6 μm). (Also, if the diameter of the spacer is not 0.6 μm, the conversion is performed based on an elastic contact theory under the press of Hertz curve. Since the theory is

disclosed in mechanical technology guide A4 (strength of materials), 109 pages (second print), 1985, their description will be omitted.

It is more preferable to the spacers D, E, and F of which a pressing load required for pressing the spacer in the seal by 10% in the state that the spacer is interposed between the pressing metal parts (rigid body) of a press deformation tester is 0.5 g or less (here, the deformation amount 0.6 μm). That is, as the material of the spacer is flexible, the pressing force applied to the transistor is absorbed by the deformation of the spacer, and the irregularity of the spacer, the irregularity of the thickness of the glass substrate, the change of the pressing force due to the existence of the driving circuit part are absorbed. (These irregularities are disadvantageous when unexpected excessive pressing force is applied, and are set in any range by a previous product test for each material) Also, at this time, as can be seen from Fig. 4, the contraction due to the load and the pressing force and the deformation of the spacer is in a proportional relationship in the range of the load of 0.5 g/number, preferably, 0.25 g/number, and the difference therebetween is 5 %, and at most 10 %. Accordingly, if the substrates are pressurized while measuring the interval between the glass substrates using laser light beam, an adequate pressing force is

maintained.

[0196]

Moreover, the spacer mixed in the seal and the spacer which is dispersed in the display region are preferably made of the same material. In case that the modulus of the elasticity or the thermal expansion is different, the resin spacer (Epostar GP-HC: Japanese showkubai, poly benzoganimine resin, poly divinyl benzene or a material similar thereto) having the difference of at most 10 % or less must be used, because it is matched with the linearlity of the deformation due to the pressing force and the expansion and contraction due to the heat is uniform in the seal part and the display part.

[0197]

Next, the seal part and the pixel part are different from each other in view of mechanical and physical properties such as rigidity and transmittance, and thus are different from each other in the density of the spacer. Thereby, the spherical elastic spacers are dispersed on an original substrate and the seal resin is coated in the seal part. At this time, spacers are mixed in the seal resin with adequate density in consideration of the spherical elastic spacer.

[0198]

(Second Embodiment)

In the present embodiment, a cylindrical protrusion for maintaining the substrate interval is formed in the driving circuit part adjacent to the display region.

[0199]

That is, although, in the previous embodiment, the spacers are mixed in the seal resin, the protrusion is formed in the present embodiment. This is shown in Fig. 5.

[0200]

Fig. 5 is a cross-sectional view of a main part of a liquid crystal panel according to the present second embodiment. Fig. 5(a) illustrates the structure of the driving circuit part and Fig. 5(b) illustrates the structure of the display region part.

[0201]

Hereinafter, the present embodiment is described.

[0202]

Similar to the first embodiment, an array such as driving transistor is manufactured at the periphery of the display region on a substrate 101 (hereinafter, the reference numeral of each part of the transistor element will be omitted, for clarity).

[0203]

Thereafter, as a spacer for maintaining the substrate interval, a semi-conical protrusion 6 consisting of an elastic material is formed on an insulating film 15 of a

part in which the seal resin is formed.

[0204]

As the forming method, photoresist is coated using a spin coating method and is processed by photolithography.

[0205]

That is, photosensitive resist (HRC-126: JSR) is coated on the array substrate using the spin coating method and then dried on a hot plate at a temperature of 90 °C for 2 minutes.

[0206]

Thereafter, the exposure is performed with $5mW/cm^2$ and then the development is performed using developing solution for 2 minutes. At this time, the protrusion is not formed in a portion in which an element is formed.

[0207]

Thereafter, a cleaning process is performed with pure water for 1 minute.

[0208]

Thereby, the protrusion having a height of 6 μm is formed on the array substrate.

[0209]

Next, a transparent conductive film (ITO film) 202 is formed on the glass substrate 102 and then an orientation film 4 (AL5417: JSR) is printed at any location on the both substrates 101 and 102.

[0210]

Seal resin 5 (struct bond: Mitsuidowatsu) is coated at the periphery of the glass substrate by a dispenser. At this time, spacers are not mixed in the seal resin. Also, the seal resin 5 is adhered on the top part of the protrusion and contributes the adhesion of the both substrates through the protrusion.

[0211]

Thereafter, similar to the first embodiment, in order to regularly maintain the substrate interval of the display region, as shown in Fig. 5(b), resin spheres 71 (Epostar GP-HC: Japanese shokubai) having a diameter 6.5 μm is dispersed as spacers in this region. Also, processes of coating a conductive paste and adhering a polarization plate to the panel are performed to manufacture a liquid crystal display panel. The pressing force or the control is similar to the first embodiment.

[0212]

Also, as a comparative example, a panel using a seal resin in which glass fiber is previously mixed as a spacer, instead of protrusion.

[0213]

At the result of observing these liquid crystal panel using a microscope, in the liquid crystal panel in which the glass fiber is mixed in the seal resin as the spacer,

scratch is generated in the driving circuit part below the seal part, because the glass fiber is hard. Thereby, if the liquid crystal panel operates, point defect or line defect is generated.

[0214]

On the contrary, if the protrusion is formed in the seal resin, scratch is not generated in the driving circuit part below the seal part although excessive pressing force is applied upon curing the seal resin. This reason is because the protrusion is flexible and is not formed at the TFT part of the driving circuit. Thereby, the image display is good.

[0215]

(Third Embodiment)

In the present embodiment, protrusions are formed in the seal part as well as the display region.

[0216]

Fig. 6 is a cross-sectional view of a liquid crystal panel according to a third embodiment. Fig. 6(a) illustrates the structure of the driving part and Fig. 6(b) illustrates the structure of the display region.

[0217]

In the present embodiment, similar to the first embodiment, the transistor arranged along the driving circuit or the pixel, that is, the array is manufactured on

the substrate 101.

[0218]

Thereafter, elastic protrusions 6 and 60 are formed in the portion in which the seal resin is formed and the display region on the substrate in which the array is formed, except a portion in which the transistor is formed.

[0219]

That is, although the spacers are mixed in the seal and dispersed in the display region in the first embodiment, the protrusions are formed in the present embodiment. The protrusions are formed at the vicinity of the pixel driving element in the display region and a non-pixel part such as a black matrix part or the boundary between the pixels (not shown), instead of the dispersion of the spacers. (There are limits in the dimension of the protrusion or the black matrix or the manufacture precision and the case that the protrusion is protruded from the black matrix may be generated. However, these do not affect the viewing).

Also, the forming method of the protrusion is similar to that of the second embodiment.

[0220]

Thereafter, a liquid crystal display panel is manufactured using the same method as the first embodiment.

[0221]

For comparison, the liquid crystal panel having the

seal resin in the glass fiber is mixed in the spacer is manufactured (not shown).

[0222]

At the result of observing these liquid crystal panel using a microscope, in the liquid crystal panel in which the glass fiber is mixed in the seal resin as the spacer, scratch is generated in the driving circuit part below the seal part, because the glass fiber is hard. Thereby, if the liquid crystal panel operates, point defect or line defect is generated.

[0223]

On the contrary, if the protrusion is formed in the seal resin, scratch is not generated in the driving circuit part below the seal part because is not formed at the TFT part of the driving circuit. Thereby, the image display is good. Thereby, it is judged that, although the protrusion is formed in the display region, it does not adversely affect the seal part.

[0224]

Furthermore, in the present embodiment, since the spacers are not dispersed in the display region of the panel and the protrusion is formed in the region other than the pixel electrode, it does not adversely affect the display of the panel, although it is photosensitive resin and thus the orientation of the liquid crystal molecules is scattered.

On the other hand, since the spacers do not exist in the pixel, the scatter of the orientation and the non-transmittance of the light are generated. Thus, the better display is accomplished.

[0225]

Moreover, in the present embodiment, since the protrusions are formed in the seal part as well as the non-pixel part of the display region, the process of dispersing the spherical resin spacers can be omitted and thus the manufacturing cost can be reduced.

[0226]

Also, when the thickness of the liquid crystal layer in the substrate is 6-7 μm and the diameter of the protrusion 5-20 μm, if the dispersion density of the cylindrical protrusion in the display region is too high, the elasticity of the liquid crystal panel is deteriorated and can track the temperature change. Further, since the protrusion acts as the resistance when injecting the liquid crystal molecules, the dispersion density is 20 number/mm^2 or less, and preferably 10 number/mm^2 or less.

[0227]

However, since this is related to the property or the amount of the liquid crystal molecules or the thickness of the glass substrate, the dispersion density may be changed.

[0228]

(Fourth Embodiment)

In the present embodiment, a protrusion is formed on the center of each pixel part of the display region.

[0229]

Fig. 7 is a cross-sectional view of a liquid crystal panel according to a fourth embodiment.

[0230]

As shown in Fig. 7(a), in this liquid crystal display panel, a semi-conical protrusion 601 having an upper diameter of 5 μm and a lower diameter of 10 μm is formed on the center of each pixel part of 100 μm× 100 μm.

[0231]

Thereby, as shown in Fig. 7(b), elliptical liquid crystal molecules are regularly arranged at the periphery of the protrusion. Accordingly, the viewing angle property of the liquid crystal panel is improved.

[0232]

Moreover, in an OCB type liquid crystal, if the molecule arrangement is anisotropic, the driving characteristics at a low voltage are improved. Also, in order to improve the effect, a protrusion for arranging the liquid crystal molecules may be provided, independent from the protrusion for maintaining the substrate interval. Also, if the protrusion spacer is formed at the pixel, the electrode, or a portion which is higher than the

polarization film, the height of the top part is different, but the vertical length becomes equal. Also, the spacer is formed by one process.

[0233]

Furthermore, as shown in Fig. 7(c), the protrusion 602 has a specific shape such as trapezoid in the section and is arranged at specific one end of the pixel. In this case, the viewing angle characteristics are improved. Also, it is suitable for a display panel having a specific viewing direction, such as a display panel in a train.

[0234]

(Fifth Embodiment)

The present embodiment relates to a projective display using a liquid crystal or a color display liquid crystal panel without using a color filter.

[0235]

Recently, as shown in Fig. 2, a liquid crystal panel in which colors of cyan, magenta, yellow or G, R, Y of a guest/host mode is mixed in the liquid crystal, or which performs color display using a filter has been developed. In this case, three liquid crystal layers divided by transparent glass exist on the bottom substrate.

[0236]

In this case, the seal part is shown in Figs. 8(a) and 8(b).

[0237]

In Fig. 8, the liquid crystal layers 301, 302, and 303 in which color of yellow, magenta, and cyan, or color of R, B, G are formed in this order from the lower part and thus the number of the substrates is 4. That is, the substrates 211, 212, 213, and 214 are arranged.

[0238]

In Fig. 8(a), driving circuits 221, 222, and 223 adjacent to the display region of each liquid crystal layer are formed on the lower substrates 211, 212, and 213. Also, a total control driving circuit 224 is provided at the periphery of the seal part of the lowest substrate 211.

[0239]

In Fig. 8(b), a total control driving circuit 224, a highest liquid crystal layer driving circuit 223, a middle liquid crystal layer driving circuit 222, and a lowest liquid crystal layer driving circuit 221 are formed on the lowest substrate 211 in this order from the left side.

[0240]

In Fig. 8(a), as the seal part, a lowest liquid crystal seal part 51 is formed, a middle layer liquid crystal seal part 52 is then formed, and a highest liquid crystal seal part 53 is finally formed. Thereby, protrusions 61, 62, and 63 for maintaining the substrate interval are formed in the seal parts 51, 52, and 53 on the peripheral driving circuit

part provided on the lower substrate.

[0241]

Next, in Fig. 8(b), the heights of the upper glass substrate and the lowest glass substrate 211 are different for each substrate of each layer. In this case, it is not preferable that the substrate interval is regularly maintained using the spherical spacers or the spacers of the fiber having different diameters for each glass substrate, because the kinds of the spacers increase.

[0242]

Accordingly, protrusions 64, 65, 66, and 67 are formed in the seal parts 51, 54, 55, and 56 on the opposite upper substrate corresponding to the driving circuit part for each liquid crystal layer.

[0243]

In this case, the wiring between the peripheral driving circuit part and the pixel corresponding thereto, the wirings 92, 93, and 93 between the peripheral driving circuit and the total control driving circuit part, or the formation of the contact hole (not shown) are accomplished by coating and curing the seal resin and forming and controlling the semiconductor element, while forming and controlling the protrusion.

[0244]

In this case, since the protrusion is formed by the

patterning in any case of Figs. 8(a) and 8(b), the forming location can be adequately controlled all in three layers. Further, the rigidity of the seal part is sufficiently high.

[0245]

Also, the present embodiment can flexibly correspond to the difference between the heights of the liquid crystal layers.

[0246]

(Sixth Embodiment)

The present embodiment relates to a color display panel having three liquid crystal layers similar to the fifth embodiment, but is different from the fifth embodiment in that a protrusion for maintaining the substrate interval is formed in the display region.

[0247]

That is, in a method for using a plurality of the liquid crystal layers for color display, if the spherical spacers for maintaining the interval between the two substrates are dispersed, the spacers of which the number is several times of that of a general color filter method are dispersed.

[0248]

However, although the spacer is made of any material, the orientation of the liquid crystal at the vicinity of the spacer is irregularly scattered. This becomes the cause of

the discretion and thus the light may be diffused. Thereby, increasing the spacer density is not preferable in view of the good display quality.

[0249]

Moreover, the distribution of the spacer density may uneven for each layer and distortion may be generated. Further, the substrate interval may different from a design value. These are not preferable in view of the good color display.

[0250]

Accordingly, in the present embodiment, a protrusion is formed on each substrate so as to maintain the substrate interval of each layer. At this time, as shown in Fig. 9, this protrusion equalizes the forming location on each substrate and is formed in the non-pixel part such as the boundary between the pixels. In Fig. 9(a), the protrusions are formed at the vicinity of the pixel driving element 17 (corresponding to 11-14 of Fig. 3) of the lower substrate of each liquid crystal layer and the non-pixel part, and, in Fig. 9(b), a relationship between the protrusion 60 of each layer and the direction of the light 40 transmitting through the liquid crystal layer is shown.

[0251]

With respect to the light rays 40, the protrusions are arranged in a line and exist in the non-transmittance part.

Thereby, the substrate interval becomes regular and the excellent display quality can be obtained.

[0252]

In Fig. 9(a), rod-shaped protrusions are formed in correspondence with each pixel. However, one protrusion may be formed for four pixels composed of 2 pixel × 2 pixel.

[0253]

(Seventh Embodiment)

In Fig. 1, the seal part is not formed at the end of the substrate. However, in order to preserve the spacer or the usage, the driving circuit is formed only on any one of the upper and lower substrates and the seal part may be formed at the end. In the present embodiment, an application of the present invention is illustrated in case that the driving circuit is formed only on any one of the substrates.

[0254]

As shown in Fig. 10(a), peripheral driving circuits 21 and 22 are formed in the range of 2 mm from the left end and 4-7 mm from the upper end of the 70mm×90mm substrate and a display region 20 is formed in the range of 88mm×63mm at the vicinity of the right lower side. The seal parts 5 are formed at the center of the peripheral driving circuit parts 21 and 22 and the right end and the lower end of the substrate.

[0255]

In this case, if the elastic resin spacer is used, it can be contracted upon solidifying and fixing the seal part. Accordingly, as shown in Fig. 10(a), the resin may flow from the end of the panel. In Fig. 10(a), 58 is the resin which flows out the end and is solidified.

[0256]

If the resin which flows outward and is solidified is disadvantageous, a cutting process must be performed. This is troublesome as the curing process.

[0257]

Accordingly, as shown in Fig. 10(c), a wall-shaped protrusion 603 is formed at the end of the substrate. Thereby, the resin 58 can be prevented from flowing outward.

[0258]

Also, in the other portion, the simple protrusion spacers 6 are formed.

[0259]

In addition, the wall-shaped protrusion may be formed at a location of several μm from the substrate end and may be formed in a broken line shape in the range that the resin does not flow outward.

[0260]

(Eighth Embodiment)

The present embodiment relates to the electric

connection of the end of the panel having the structure that the plurality of the liquid crystal layers shown in Fig. 2 or 8 overlap.

[0261]

In this case, as shown by 91 of Fig. 2 or 91-94 of Fig. 8, connection line part for electrically connecting the lowest substrate and each substrate is required. However, in case of forming the connection line part at the section of each substrate, the resin flows from the substrates and is solidified.

[0262]

That is, although the glass spacers are used and thus the deformation due to the press is not generated, the resin flows from the substrate, because the volume is expanded due to the foam or chemical response. Accordingly, in this case, it is disadvantageous in the adhering of the seal having the connection line part formed at the inner surface or the outer surface or the bonding of the thin plate.

[0263]

Accordingly, in the present embodiment, the wall-shaped and rod-shaped protrusion which is also used for the wall for preventing the resin from flowing outward is formed at the section of each substrate or the inside of 2-3 μm therefrom. Thereby, the seal is easily adhered as the connection line part.

[0264]

The case that the panel having the three liquid crystal layers shown in Fig. 8(a) is applied is shown in Fig. 11(a). Fig. 11(b) is a modification thereof.

[0265]

As shown in the right side of Fig. 11(b), connection line parts 91-93 of the substrate of each layer is adhered to the section in order. Also, the connection line part has a wiring 95 formed in the contact hole, as shown in the left side of Fig. 11(b). Alternatively, the contact hole is formed in the wall-shaped and rod-shaped protrusion.

[0266]

(Ninth Embodiment)

In the present embodiment, a film which is also used for the polarization film or the color filter or a thin film consisting of seal resin and having a thickness of 1-3 μm is formed in the driving circuit part, and then a seal resin in which the cylindrical glass fiber is mixed is coated and is cured by heat.

[0267]

This is shown in Fig. 12.

[0268]

In this case, since the glass fiber 19 does not directly contact with the transistor 15 in the state that the resin film or the seal resin layer 18 exists, the

transistor is not damaged although the pressing force which is two times as large as the general case is applied. Since a portion in which the lower seal resin layer exists has a thickness of 1 μm, which is very smaller than the seal width of 1 mm, the volume is not changed the seal part has sufficient rigidity and height precision.

[0269]

Moreover, in this case, the pressing is performed upon curing the seal resin of a first layer. However, since this resin layer is thin and the volume thereof is hardly changed according to the curing, the maintenance of the substrate interval can be sufficiently controlled upon curing the seal resin part 57 containing the glass fiber.

[0270]

Furthermore, since the resin film can be formed in correspondence with the polarization film, the manufacture becomes easy.

[0271]

(Tenth Embodiment)

In the present embodiment, a nylon fiber having a length which is one time to three times of the diameter, and, preferably, 1.t times (+-0.5 times) is used instead of the glass fiber. That is, if the diameter is 6 μm, the length is 10 μm.

[0272]

In this case, since the nylon has polarity group, it is congenial to the seal resin having polarity group.

[0273]

Moreover, since the nylon has a short cylindrical shape, it can not overlap and move in a horizontal direction upon the pressing. In addition, since the seal part is away from the display region, the orientation of the pixel is not scattered by the nylon fiber. Further, the display quality is not changed and the excellent seal part is formed.

[0274]

Furthermore, in the present embodiment, in Fig. 12, the seal resin layer 18 is not formed, and the particle-shaped glass fiber 19 is substituted with the cylindrical nylon fiber and is not separately shown.

[0275]

(Eleventh Embodiment)

The present embodiment relates to formation of the protrusion in the display part and the seal part.

[0276]

Fig. 14 is a plan view of a liquid crystal panel according to the present embodiment.

[0277]

Fig. 15 illustrates the structure of a main part of the liquid crystal panel of the present embodiment. Fig. 15(a) illustrates the structure of the pixel and Fig. 15(b)

illustrates a cross-sectional view taken along a line A-A. Fig. 15(c) is a cross-section view of the seal part.

[0278]

Hereinafter, this liquid crystal panel will be described with reference to Figs. 14 and 15.

[0279]

An image signal line (source) 110 and a scan signal line (gate) 111 are formed on a glass substrate 101 in a matrix as a metal wiring, and a semiconductor layer (TFT) is formed at the intersection thereof as an active element (switching element).

[0280]

The below description is directly related to the idea of the present invention and is known. However, since the present invention is based on this technology, the formation of the semiconductor layer, the color filter, or the orientation film will be schematically described.

[0281]

A gate electrode is selectively formed on a glass substrate 101 using metal such as Al. Here, the glass substrate 101 has a display part having a diagonal length 48 cm and a thickness of 0.7 mm. Next, SiN_x which is a first gate film is formed with a thickness of 3000 Å using a plasma CVD method.

[0282]

Next, a semiconductor layer (amorphous silicon layer) which becomes a channel part of the transistor is formed with a thickness of 500 Å, and SiN_x which becomes an etching stopper is then formed with a thickness of 1500 Å.

[0283]

At this time, as the method for forming the channel part of the transistor, the insulating film SiN_x is formed on the gate electrode so that it is smaller than the gate electrode and is used as the etching stopper, and n+ amorphous silicon layer containing phosphorous is formed thereon with a thickness of 500 Å using the plasma CVD method, thereby obtaining ohmic contact (n+ is high-density doping and has high n-type impurity ratio).

[0284]

Next, a contact hole is formed at the periphery for forming an electrode and contacts with the wirings.

[0285]

Next, a transparent conductive film (ITO) is formed.

[0286]

Next, a signal wiring (source line) and a drain line are formed with a thickness of 4000 Å using metal such as Al/Ti.

[0287]

Thereafter, in order to protect the wiring, SiN_x is formed as a second insulating film (passivation film) with a

thickness of 3500 Å using the plasma CVD method.

[0288]

Also, at this time, after cleaning the substrate, the resist is coated by a spinner and the exposure is performed so that a portion of the insulating film is not formed on the pixel electrode.

[0289]

Moreover, a color filter layer is formed on an opposite glass substrate 102.

[0290]

The color filter layer is obtained by coating colored resist in which pigment is dispersed in acrylic photosensitive resin on a substrate, providing a mask on a needed portion or using patterned light to perform the exposure, and developing and removing unnecessary portions (photolithography) for each color of Red, Green, Blue, and Black. Here, black is used because of the black matrix.

[0291]

The substrate having this state is shown in Fig. 15(b) or 15(c) (the seal of the end or the protrusion spacer is not formed in this step). Also, the dimension of the pixel is 0.3 mm.

[0292]

In Fig. 15(b) and 15(c), 102 and 101 are the upper and lower glass substrates. 155 is any one of the color filters

of R, G, B, and 156 is a black color filter. 202 and 201 are the upper and lower pixel electrode and 4 is the upper and lower orientation film. Also, 5 is the seal resin and 6 and 60 are the protrusion spacers. Further, 17 is the semiconductor element formed in the above-mentioned order. Also, a transparent insulating ceramic film for preventing the impurities from being diffused from the glass and an insulating film for protecting the semiconductor element 17 may be formed, but are directly related to the idea of the present invention and thus are not shown. The other drawings are similar.

[0293]

Next a transparent conductive film (ITO) is formed.

[0294]

Next, a protrusion is formed as a spacer. As the forming method, the below-mentioned processes are performed using the photosensitive acrylic resin (PC335: JSR).

[0295]

The photosensitive acrylic resin (PC335: JSR) is coated on a substrate by a spin coating method and then pre-baked at a temperature of 80 °C for 1 minutes. Thereafter, the exposure is performed using a predetermined mask with 300 mj/cm^2. Then, the development is performed using a developing solution CD702AD at 25 °C for 1 minute and the substrate is cleaned and post-baked at 220 °C for 1 hour to

form a protrusion having a film thickness of 5.0 μm.

[0296]

Moreover, at this time, the location that the protrusion is formed is in the display part. But, when being adhered with the array substrate, the location becomes the location of the pixel electrode, for example, the place 61 shown in Fig. 15(a). Accordingly, the protrusion is formed on the color filter substrate 102 (Accordingly, in Fig. 15(b), the protrusion spacer formed at the place 61 is shown the side opposite to the A-A section).

[0297]

In the area of the protrusion, the area of the square-shaped lower surface of which one side has a length of 10 μm is 100 μm^2 and the area of the square-shaped upper surface of which one side has a length of 8 μm is 64 μm^2, and the ratio of the area of the upper surface to the area of the lower surface is 0.64.

[0298]

Also, the density of the protrusion is 10 number/mm^2 in the display region and is 40 number/mm^2 in the seal region.

[0299]

Next, an orientation film 4 (AL5417: JSR) is printed on the array substrate and the opposite substrate, is cured, and is subjected to a rubbing process. Since the protrusion is formed, soft nylon fabric using a thin yarn in the

rubbing process. Also, an incomplete portion may be formed in a portion adjacent to the protrusion. However, since this portion is the black matrix, the display performance is not adversely affected. Also, in order to obtain complete orientation in a portion adjacent to the protrusion, the other orientation process such as ultraviolet ray irradiation may be performed. Of course, these two method may used together.

[0300]

Next, seal resin 5 (struct bond: Mitsuidowatsu) is printed at the periphery of the opposite substrate 102 with a width of 2 mm.

[0301]

Thereafter, the both substrates are stuck to each other and are heated at 150 °C for 2 hours to cure the seal resin.

[0302]

A liquid crystal (MT5087: Chiso corporation) is injected into the empty panel manufactured using the above-mentioned method.

[0303]

Thereafter, photosensitive resin (Rock tait 352A: Japanese Rock tait) is coated on the entire injecting port of the liquid crystal panel as a seal resin and the light is irradiated to cure the seal resin for 5 minutes with 10 mW/cm^2.

[0304]

Next, polarization plates (NPT-HEG1425DU: Nitto denko) are adhered to the upper and lower sides of the panel composed of the both substrates.

[0305]

For comparison, in order to equalize the cell thickness, instead of the protrusion, resin spheres 71 (Eposta GP-H50: Japanese Shokubai) having a diameter 5.0 μm is dispersed in the display region as the spacer and the seal resin in which the glass fiber 19 (PF-50S: Japanese electric glass) having a short-axis diameter of 5.0 μm is mixed is used to manufacture a liquid crystal panel. This is shown in Fig. 16. Also, in Fig. 16, the circular section of the glass fiber is shown. Also, the other condition is similar.

[0306]

The result of comparing two liquid crystal panels is as follows: In the liquid crystal panel having the protrusion, good orientation is observed, but, in the liquid crystal panel having the dispersion spacer, the uneven cell thickness is generated and thus uneven display is generated. Also, in the liquid crystal panel having the dispersion spacer, the deviation of the glass fiber mixing degree is generated depending on the location and thus the seal is uneven or the rigidity is changed. These problems are not preferable in the display quality and the demand of the user.

[0307]

Next, in the shape of the protrusion, particularly, the ratio of the area of the upper surface (display surface) to the area of the lower surface, it is preferable that 0.2<area of the upper surface/area of the lower surface<0.9. That is, if the area of the upper surface is too small (smaller than 0.2), the rigidity is deteriorated and accurate cell thickness can not be formed, and, if the area of the upper surface is too large (larger than 0.9), the orientation defect such as discretion is apt to be generated. Also, the above-mentioned area ratio is accomplished by rapidly performing the post-bake process to generate overheat. Alternatively, the other means such as a means for diagonally irradiating ultraviolet rays in a plurality of the directions may be used.

[0308]

The area ratio is adequately selected in consideration of the kind of the liquid crystal, the dimension of the pixel, and the forming location on the panel or the usage of the panel and may have the other values. Also, in case that the protrusion is formed on the opposite substrate, the protrusion spacer is not suitable.

[0309]

Also, in case that the dimensions of the protrusions are different depending on the location, instead of the

orientation film, a lower layer of the spacer is previously formed by an orientation film forming material layer before forming the cylindrical protrusion spacer, and ultraviolet ray irradiation or chemical material deposition or coating may be performed so that the lower layer acts as the orientation film while compensating the difference therebetween.

[0310]

(Twelfth Embodiment)

The present embodiment is similar to the eleventh embodiment except that a height controlling film is formed at the lower side of the protrusion so as to equalize the cell thickness.

[0311]

Particularly, in the array substrate, the heights of the seal part and the pixel part are different from each other. Accordingly, as shown in Fig. 17, a height controlling film 154 is previously formed at the lower side of the protrusion in a region in which the seal 5 is formed. This film may be made of metal such as Al or Cu or resin.

[0312]

By forming the height controlling film, the height of the protrusion spacer is equalized, although irregularities exist depending on the location of the substrate. Accordingly, uniform cell thickness can be ensured and the

rigidity of the protrusion spacer is equalized. Thus, the rigidity required for the panel depending on the place such as the seal part and the display part is sufficiently satisfied. Also, unlike Fig. 17, this film may be formed only below the protrusion spacer.

[0313]

(Thirteenth Embodiment)

The present invention is similar to the eleventh embodiment except that the density of the protrusion is changed.

[0314]

The result of the display quality when changing the density of the protrusion in the seal region and the density of the protrusion in the display region is shown in Table 1.

[0315]

Table 1

Density of protrusion in the display region (number/mm^2)	3	5	10	20	30	40	50	60	70	80
Display quality	△	○	◎	○	○	○	○	△	△	X

Density of protrusion in the seal region	3	5	10	20	40	60	80	100	120	140

(number/mm^2)										
Display quality	△	△	○	○	◎	○	○	△	△	X

◎ : very good, ○ : good, △ : slightly bad, X: bad

[0316]

As shown in Table 1, if the number of the protrusions in the display region is too large, the liquid crystal panel is too hard. Accordingly, when the temperature is changed, the expansion and contraction of the protrusion do not follow the expansion and the contraction of the liquid crystal and thus foam may be generated.

[0317]

Also, if the numbers of the protrusions in the seal region and the display region are too smaller, the protrusion does not serve as the spacer.

[0318]

However, the protrusion in the seal region does not contact with the liquid crystal and is not affected by the expansion and the contraction of the liquid crystal, because it is contained in the seal resin. On the other hand, the difference between the expansion coefficients of the protrusion and the seal resin exists, but can be reduced by forming the protrusion by the resin. Thereby, the density of the protrusion in the seal region is higher than that of the protrusion in the display region. Also, by increasing

the density, the panel distortion is reduced and thus the liquid crystal panel having uniform display performance can be obtained.

[0319]

It is preferable that the density of the protrusion in the display region is in the range of 5 number/mm^2 to 50 number/mm^2 and the density of the protrusion in the seal region is in the range of 10 number/mm^2 to 80 number/mm^2. It is more preferable that the density of the protrusion in the display region is in the range of 10 number/mm^2 to 15 number/mm^2 and the density of the protrusion in the seal region is in the range of 30 number/mm^2 to 50 number/mm^2.

[0320]

(Fourteenth Embodiment)

The present invention is also similar to the eleventh embodiment except that the density and the size of the protrusion are changed.

[0321]

In the size and the density of the protrusion in the display region, the area of the square-shaped lower surface of which one side having a length of 10 μm is 100 μm^2 and the area of the square-shaped upper surface of which one side has a length of 8 μm is 64 μm^2, and the ratio of the area of the upper surface to the area of the lower surface is 0.64.

[0322]

Furthermore, in the protrusion in the seal region, the area of the square-shaped lower surface of which one side having a length of 20 μm is 400 μm^2 and the area of the square-shaped upper surface of which one side has a length of 15 μm is 225 μm^2, and the ratio of the area of the upper surface to the area of the lower surface is 0.5625.

[0323]

Moreover, the density of the protrusion is 20 number/mm^2 in both the display region and the seal region.

[0324]

Since the size of the protrusion in the seal region is larger than that of the protrusion in the display region, the seal part becomes strong and the distortion of the panel is reduced. Thus, the liquid crystal panel having the uniform display performance can be obtained.

[0325]

(Fifteenth Embodiment)

The present invention is also similar to the eleventh embodiment except that the area ratio of the lower surface of the protrusion is changed.

[0326]

The result of the display quality when changing the area ratio of the protrusion formed in the display region to the display region and the area ratio of the protrusion formed in the seal region to the seal region is shown in

Table 2.

[0327]

Table 2

Ratio of the protrusion formed in the display region to the display region (%)	0.01	0.05	0.1	0.5	1.0	1.5	2.0
Display quality	△	○	○	○	△	△	X

Ratio of the protrusion formed in the seal region to the seal region (%)	0.01	0.05	0.1	0.5	1.0	1.5	2.0
Display quality	△	△	○	○	○	△	△

○ : good, △ : slightly bad, X: bad

[0328]

As shown in Table 1, if the area of the protrusion in the display region is too large, the liquid crystal panel is too hard. Accordingly, when the temperature is changed, the expansion and contraction of the protrusion do not follow the expansion and the contraction of the liquid crystal and thus foam may be generated. On the other hand, if the area of the protrusion in the density region is too small, the protrusion can not serve as the spacer.

[0329]

Moreover, even in the seal region, if the area of the protrusion is too small, the protrusion can not serve as the spacer. Similar to the thirteenth embodiment, since the protrusion in the seal region does not contact with the liquid crystal and is not affected by the expansion and the contraction of the liquid crystal. On the other hand, the difference between the expansion coefficients of the protrusion and the seal resin exists, but can be reduced by forming the protrusion by the resin. Accordingly, the area of the protrusion can be larger than that of the protrusion in the display region. Thereby, although the seal part is strongly fixed, the panel distortion is reduced and thus the liquid crystal panel having uniform display performance can be obtained.

[0330]

The ratio of the protrusion formed in the display region to the display region is in the range of 0.05% to 0.5% and the ratio of the protrusion formed in the seal region to the seal region is in the range of 0.1% to 1.0%.

[0331]

(Sixteen Embodiment)

The present embodiment relates to the research into the liquid crystal injection. The present embodiment is similar to the eleventh embodiment except the liquid crystal

injecting method.

[0332]

While, in the eleventh embodiment, the liquid crystal is injected using the vacuum injecting method, the below-mentioned method is performed in the present embodiment.

[0333]

First, the steps for printing the orientation film (AL5417: JSR) on the array substrate and the opposite substrate and performing the rubbing process are similar to the eleventh embodiment.

[0334]

Thereafter, UV (ultraviolet ray) curing resin (World Rock 886M: Kyoritsukasei) is printed at the periphery of the opposite substrate as the seal resin. Next, the liquid crystal is dripped at several locations on the display region using a dispenser (a liquid injecting device used in the liquid crystal field) by a predetermined weight.

[0335]

Subsequently, the both substrates are stuck to each other in a vacuum of 0.1 Torr. The display region part is covered with a light shielding mask and UV light is irradiated to only the seal part by 1500 mj to cure the seal.

[0336]

Next, the liquid crystal panel is introduced into the high-temperature bath at 110 °C for 1 hour so that the

dripped liquid crystal is spread over the display region.

[0337]

Fig. 18 schematically illustrates the liquid crystal injecting state.

[0338]

However, as shown in Fig. 18(a), since the liquid crystal is injected into the panel through one injecting port 30 and is spread over the panel in the conventional vacuum injecting method, the area that the liquid crystal flows is large and the injecting time is long. Particularly, the liquid crystal is rapidly introduced into the empty panel upon the beginning of the injection. In this case, the liquid crystal is influenced by the protrusion in the display region and thus the impurities contained in the protrusion may be melt in the liquid crystal. Accordingly, uneven orientation and display defect can be generated.

[0339]

On the contrary, as shown in Fig. 18(b), in case that the liquid crystal is dripped at several places on the substrate and then the liquid crystal is filled in the panel by sticking the both substrates, the liquid crystal flow from the dripped point 80 is weak, the flowing area is small, and the injecting time is short. Accordingly, the liquid crystal is not influenced by the spacer upon the injection, and thus uneven display is not generated and the liquid

crystal panel having good display quality can be obtained. Also, the arrows shown in Figs. 18(a) and 18(b) represent the liquid crystal flow and the thickness and the length thereof represents the flow strength.

[0340]

Moreover, since the ultraviolet rays are irradiated to only the seal resin, the liquid crystal is not deteriorated due to the ultraviolet rays.

[0341]

(Seventeenth Embodiment)

The present embodiment is similar to the eleventh embodiment except that a protrusion is formed on the array substrate.

[0342]

Fig. 19 illustrates the structure of a liquid crystal panel according to the present embodiment.

[0343]

Hereinafter, this liquid crystal panel will be described.

[0344]

A gate electrode is selectively formed on a glass substrate using metal such as Al. Next, SiN_x which is a first gate film is formed with a thickness of 3000 Å using a plasma CVD method.

[0345]

After cleaning the substrate, the resist is coated by a spinner and the mask exposure is performed so that a portion of the insulating film 2 is not formed on the pixel electrode (These steps are similar to those of the eleventh embodiment).

[0346]

Next, a protrusion is formed. As the forming method, the below-mentioned method is performed using photosensitive acrylic resin (PC335: JSR).

[0347]

The photosensitive acrylic resin (PC335: JSR) is coated on a substrate by a spin coating method and then pre-baked at a temperature of 80 °C for 1 minutes. Thereafter, the exposure is performed using a predetermined mask with 300 mj/cm^2. Then, the development is performed using a developing solution CD702AD at 25 °C for 1 minute and the substrate is cleaned and post-baked at 220 °C for 1 hour to form a protrusion having a film thickness of 5.0 μm.

[0348]

The protrusion is formed at the portion without the pixel electrode on the array substrate.

[0349]

Furthermore, the protrusion 60 is formed on the array substrate 1 in which the seal resin 5 is formed. Here, the density of the protrusion is 10 number/mm^2 in the display

region and 40 number/mm^2 in the seal region. Also, in the area of the protrusion, the area of the square-shaped lower surface of which one side has a length of 10 μm is 100 μm^2 and the area of the square-shaped upper surface of which one side has a length of 8 μm is 64 μm^2, and the ratio of the area of the upper surface to the area of the lower surface is 0.64.

[0350]

Moreover, a color filter layer is formed on the opposite glass substrate 102. The color filter layer 155 is obtained by coating colored resist in which pigment is dispersed in acrylic photosensitive resin on a substrate, performing the exposure, and developing and removing unnecessary portions (photolithography) for each color of Red, Green, Blue, and Black.

[0351]

Next, a transparent conductive film (ITO) is formed.

[0352]

Subsequently, an orientation film 4 (AL5417: JSR) is printed on the array substrate 101 and the opposite substrate 102, is cured, and is subjected to a rubbing process.

[0353]

Next, seal resin (struct bond: Mitsuidowatsu) is printed at the periphery of the opposite substrate.

Thereafter, the both substrates are stuck to each other and are heated at 150 °C for 2 hours to cure the seal resin.

[0354]

A liquid crystal (MT5087: Chiso corporation) is injected into the empty panel manufactured using the above-mentioned method.

[0355]

Thereafter, photosensitive resin (Rock tait 352A: Japanese Rock tait) is coated on the entire injecting port of the liquid crystal panel as a seal resin and the light is irradiated to cure the seal resin for 5 minutes with 10 mW/cm^2.

[0356]

Next, polarization plates (NPT-HEG1425DU: Nitto denko) are adhered to the upper and lower sides of the panel composed of the both substrates. This state is shown in Figs. 19(b) and 19(c) and corresponds to Figs. 15(b) and 15(b). In Figs. 19(b) and 19(c), since the cylindrical protrusion spacers 6 and 60 are formed on the array substrate 101, the substrate is thin.

[0357]

In the liquid crystal panel of the present embodiment, uniform display is observed at the center of the display region and the vicinity of the seal. Also, in the present embodiment, by forming the protrusion, a process for mixing

the glass fiber in the seal material, a process for dispersing the spacers, a pre-dispersing process, and a process for cleaning a dispersing device can be omitted.

[0358]

Moreover, although, in the present embodiment, the protrusion is made of the photosensitive resin, it may be made of an insulating film such as SiN_x instead of the photosensitive resin. Since the insulating film such as SiN_x or SiO_2 can be formed by a conventional array process, the material or factory equipment can be reduced.

[0359]

Also, as shown in Fig. 20(b), a planarization layer 153 may be formed on the switching element such as TFT using a spin coating method and the electrode 201 or the protrusion 60 may be formed thereon. The planarization layer 153 is made of resin which can flat the surface or an insulating film such as SiN_x. By this structure, the area of the pixel electrode can be widened.

[0360]

Moreover, as shown in Fig. 20(c), a height controlling film 154 is formed and a protrusion spacer 69 is formed thereon.

[0361]

Thereby, the height of the protrusion spacer is equalized although the heights of the parts of the array

substrate are different from one another, and thus the protrusion spacer is formed by one process.

[0362]

Furthermore, the planarization film 153 and the height controlling film 154 are made of the same material and are simultaneously formed. The planarization film also serves as an orientation film. In this case, in the display part of the pixel, the planarization film is most thin and low light absorption by forming the pixel electrode and the insulating film. Also, the planarization film has a sufficient function as the orientation film.

[0363]

Also, the planarization film serves as a color filter of reflective liquid crystal display device.

[0364]

At this time, the pixel electrode may overlap with the source electrode or the gate electrode. Also, Figs. 20(b) and 20(c) correspond to Figs. 15(a) and 15(b) and Fig. 17(a) and 17(b).

[0365]

(Eighteenth embodiment)

The present embodiment is similar to the seventeenth embodiment except for the liquid crystal injecting method.

[0366]

In the liquid crystal injection of the present

embodiment, the liquid crystal is dripped on the substrate, similar to the sixteenth embodiment.

[0367]

If the liquid crystal is injected by sticking the both substrates after dripping the liquid crystal on the substrate, the liquid crystal flow is weak, the flowing area is small, and the injecting time is short. Accordingly, the liquid crystal is not influenced by the spacer upon the injection, and thus the uneven display is not generated and the liquid crystal panel having good display quality can be obtained.

[0368]

(Nineteen Embodiment)

In the present embodiment, a protrusion spacer and a color filter are formed on the array substrate.

[0369]

Fig. 21 illustrates the structure of a liquid crystal panel of the present embodiment.

[0370]

Hereinafter, this liquid crystal panel will be described.

[0371]

Figs. 21(b) and 21(c) correspond to Figs. 15(b) and 15(c), Figs. 17(b) and 17(c), and Figs. 20(b) and 20(c).

[0372]

In Figs. 21(b) and 21(c), 6 and 60 are cylindrical protrusion spacers. 155 is any one of the color filters of R, G, B, and 156 is a black color filter, which are formed on the array substrate. 201 is an electrode on a lower substrate 101 and 202 is an electrode on an upper substrate 102. 4 is an orientation film. 154 is a height controlling film.

[0373]

Hereinafter, a method for manufacturing this liquid crystal display device will be described.

[0374]

Similar to the eleventh embodiment, a gate electrode is selectively formed on a glass substrate using metal such as Al.

[0375]

The process from the next step to the step for forming SiN_x with a thickness of 3500 Å using a plasma CVD method as a second insulating film are similar to those of the eleventh embodiment.

[0376]

Next, unlike the eleventh embodiment, a color filter layer 155 is formed on the array substrate 101.

[0377]

The color filter layer 155 is obtained by coating colored resist in which pigment is dispersed in acrylic

photosensitive resin on a substrate, providing a mask on a needed portion or using patterned light to perform the exposure, and developing and removing unnecessary portions (photolithography) for each color of Red, Green, Blue, and Black. Here, black is used because of the black matrix.

[0378]

Next, a transparent conductive film (ITO) is formed on the color filter layer.

[0379]

Next, a protrusion is formed. As the forming method, the below-mentioned method is performed using photosensitive acrylic resin (PC335: JSR).

[0380]

The photosensitive acrylic resin (PC335: JSR) is coated on a substrate by a spin coating method and then pre-baked at a temperature of 80 °C for 1 minutes. Thereafter, the exposure is performed using a predetermined mask with 300 mj/cm^2. Then, the development is performed using a developing solution CD702AD at 25 °C for 1 minute and the substrate is cleaned and post-baked at 220 °C for 1 hour to form a protrusion having a film thickness of 3.0 μm.

[0381]

The protrusion is formed at the portion without the pixel electrode on the array substrate.

[0382]

Furthermore, as shown in Fig. 21(c), the protrusion is formed on the array substrate 101 in which the seal resin is formed. A height controlling film 62 is formed below the protrusion 6. This film may be metal such as Al or Cu or resin. Here, the density of the protrusion is 10 number/mm^2 in the display region and 40 number/mm^2 in the seal region. Also, in the area of the protrusion, the area of the square-shaped lower surface of which one side has a length of 10 μm is 100 μm^2 and the area of the square-shaped upper surface of which one side has a length of 8 μm is 64 μm^2, and the ratio of the area of the upper surface to the area of the lower surface is 0.64.

[0383]

Next, a transparent conductive film (ITO) is formed on the opposite glass substrate.

[0384]

Subsequently, an orientation film 4 (AL5417: JSR) is printed on the array substrate 101 and the opposite substrate 102, is cured, and is subjected to a rubbing process.

[0385]

Next, seal resin (struct bond: Mitsuidowatsu) is printed at the periphery of the opposite substrate.

[0386]

Thereafter, the both substrates are stuck to each other

and are heated at 150 °C for 2 hours to cure the seal resin.

[0387]

A liquid crystal (MT5087: Chiso corporation) is injected into the empty panel manufactured using the above-mentioned method.

[0388]

Thereafter, photosensitive resin (Rock tait 352A: Japanese Rock tait) is coated on the entire injecting port of the liquid crystal panel as a seal resin and the light is irradiated to cure the seal resin for 5 minutes with 10 mW/cm^2.

[0389]

Next, polarization plates (NPT-HEG1425DU: Nitto denko) are adhered to the upper and lower sides of the panel composed of the both substrates.

[0390]

In the liquid crystal panel of the present embodiment, uniform display is observed at the center of the display region and the vicinity of the seal.

[0391]

Also, in the present embodiment, by forming the color filter on the array substrate, margin of positioning precision of the array substrate and the opposite substrate becomes wide.

[0392]

Moreover, although, in the present embodiment, the protrusion is made of the photosensitive resin, it may be color filter material such as black matrix. Thereby, since protrusion can be formed by a conventional manufacturing method, the material cost or factory equipment can be reduced.

[0393]

(Twentieth Embodiment)

The present embodiment is similar to the nineteen embodiment except that the liquid crystal injecting method is changed.

[0394]

The liquid crystal injection is performed by dripping the liquid crystal on the substrate, similar to sixteen embodiment.

[0395]

Thereby, good display is accomplished, similar to the sixteen embodiment.

[0396]

(Twenty-first Embodiment)

In the present embodiment, a protrusion is formed on the array substrate and the opposite substrate.

[0397]

Figs. 22 and 23 illustrate a liquid crystal panel of the present embodiment. Also, Figs. 22(b) and 22(c)

correspond to Figs. 15(a) and 15(b).

[0398]

In the present embodiment, as shown in Figs. 22(b) and 23, the cylindrical protrusion spacer 60 is formed on the orientation film 4 of the opposite substrate 102 in the pixel part, and is formed on the end of the array substrate 101 in the seal part. Also, since the other film is formed, the array substrate is longer.

[0399]

Hereinafter, a method for manufacturing this liquid crystal display device will be described.

[0400]

Similar to the eleventh embodiment, a gate electrode is selectively formed on a glass substrate using metal such as Al.

[0401]

The processes from the next step to the step for cleaning the substrate, coating the resist by a spinner and performing the exposure so that a portion of the insulating film is not formed on the pixel electrode are similar to those of the eleventh embodiment.

[0402]

Next, a protrusion is formed. As the forming method, the below-mentioned method is performed using photosensitive acrylic resin (PC335: JSR).

[0403]

The photosensitive acrylic resin (PC335: JSR) is coated on a substrate by a spin coating method and then pre-baked at a temperature of 80 °C for 1 minutes. Thereafter, the exposure is performed using a predetermined mask with 300 mj/cm^2. Then, the development is performed using a developing solution CD702AD at 25 °C for 1 minute and the substrate is cleaned and post-baked at 220 °C for 1 hour to form a protrusion having a film thickness of 5.0 μm.

[0404]

The protrusion is formed at the portion without the pixel electrode, for example, at a location 61 in Fig. 15(a).

[0405]

Furthermore, the protrusion is formed on the array substrate in which the seal resin is formed.

[0406]

At this time, the density of the protrusion is 5 number/mm^2 in the display region and 20 number/mm^2 in the seal region.

[0407]

Also, in the area of the protrusion, the area of the square-shaped lower surface of which one side has a length of 10 μm is 100 μm^2 and the area of the square-shaped upper surface of which one side has a length of 8 μm is 64 μm^2, and the ratio of the area of the upper surface to the area of

the lower surface is 0.64.

[0408]

Moreover, a color filter layer is formed on the opposite glass substrate. The color filter layer is obtained by coating colored resist in which pigment is dispersed in acrylic photosensitive resin on a substrate, performing the exposure, and developing and removing unnecessary portions (photolithography) for each color of Red, Green, Blue, and Black.

[0409]

Next, a transparent conductive film (ITO) is formed on the opposite glass substrate. Next, a protrusion is formed. The protrusion 60 is formed by the same method as the protrusion formed on the array substrate, but the coating condition is changed. Thus, the height of the protrusion 60 is 5 μm.

[0410]

Subsequently, an orientation film 4 (AL5417: JSR) is printed on the array substrate and the opposite substrate, is cured, and is subjected to a rubbing process.

[0411]

Next, seal resin (struct bond: Mitsuidowatsu) is printed at the periphery of the opposite substrate.

[0412]

Thereafter, the both substrates are stuck to each other

and are heated at 150 °C for 2 hours to cure the seal resin.

[0413]

A liquid crystal (MT5087: Chiso corporation) is injected into the empty panel manufactured using the above-mentioned method.

[0414]

Thereafter, photosensitive resin (Rock tait 352A: Japanese Rock tait) is coated on the entire injecting port of the liquid crystal panel as a seal resin and the light is irradiated to cure the seal resin for 5 minutes with 10 mW/cm^2.

[0415]

Finally, polarization plates (NPT-HEG1425DU: Nitto denko) are adhered to the upper and lower sides of the panel composed of the both substrates.

[0416]

In the liquid crystal panel of the present embodiment, uniform display is observed at the center of the display region and the vicinity of the seal.

[0417]

Also, in the present embodiment, by forming the protrusions on the both sides of the array substrate and the opposite substrate, the liquid crystal panel is pressed by the both substrates and a strong liquid crystal panel can be obtained.

[0418]

Moreover, although, in the present embodiment, the protrusions are formed in the display part and the seal part of the array substrate and the opposite substrate, the protrusions are divided into the display part and the seal part. For example, the protrusion is formed on only the display part of the array substrate and the seal part of the opposite substrate.

[0419]

Furthermore, although, in the present embodiment, the protrusions of the both substrate are formed using the same method, they may be formed using different methods.

[0420]

(Twenty-second Embodiment)

The present embodiment is similar to the twenty-first embodiment except that the liquid crystal injecting method is changed.

[0421]

In the present embodiment, the liquid crystal is injected using the dripping method, similar to the sixteenth embodiment.

[0422]

Thereby, the uneven display is not generated and a liquid crystal having good display quality can be obtained.

[0423]

(Twenty-third Embodiment)

The present embodiment is similar to the eighteen embodiment, except that a protrusion 604 is continuously formed to surround the entire region in which the seal is formed.

[0424]

This state is shown in Fig. 24. As shown in Fig. 24, by continuously forming the protrusion 604, the affect of moisture from the outside is hardly subjected and thus a liquid crystal panel having high reliability can be manufactured.

[0425]

Also, in this case, this protrusion spacer may be formed on a color filter (not shown) of the substrate surface. Also, as shown in Fig. 25, a protrusion spacer 605 may be formed with an injecting port 30 so that the liquid crystal panel can be easily manufactured by the vacuum injection.

[0426]

(Twenty-fourth Embodiment)

The present embodiment relates to a reflective liquid crystal panel.

[0427]

Fig. 26 illustrates the structure of a main part of a liquid crystal panel of the present embodiment. Fig. 26(a)

is a cross-sectional view of a display region and Fig. 26(b) is a cross-sectional view of an end. 203 is a lower electrode formed on a lower substrate, which serves as reflector. 202 is a conductive film on an upper substrate. 155r, 155g, and 155b are red, green, and blue color filters, respectively. Also, the color filters serve as black matrix in the non-display region of the pixel. Also, in the display region of the pixel, unnecessary color filter is removed.

[0428]

4 is an orientation film. 170 is various films on the surface of the lower substrate.

[0429]

In Fig. 26(a), 60 is a protrusion space formed in the black matrix, which is shown by 61 in Fig. 15 (Accordingly, in this portion, all three color filters exist). 6 is an elastic protrusion spacer formed on the end of the panel.

[0430]

In the present embodiment, the orientation film 4 of the upper substrate is formed using a spin coating method and also serves a planarization film for removing irregularities of the upper and lower substrate. Thereby, the elastic protrusion space is formed with a uniform height in the display region and the non-display region, and thus can be formed by the same process.

[0431]

Moreover, since the upper and lower substrate are flat, the foam is not generated due to gas which exist in the irregularities although the liquid crystal is filled in the empty panel using a method other than the vacuum injecting method.

[0432]

Further, since the elastic part composed of the orientation film or the color filter exists between the upper and lower substrates, the expansion and the contraction due to the humidity change can be absorbed and the glass substrate is not suffered from the impact due to the user error.

[0433]

(Twenty-fifth Embodiment)

The present embodiment relates to a high molecular dispersion type or a liquid crystal and resin filter mixing type liquid crystal. Fig. 27 illustrates a method for manufacturing a liquid crystal panel of the present embodiment.

[0434]

Fig. 27(a) illustrates the state that an elastic protrusion spacer 60 is formed on a black matrix in a display region of a lower substrate 101 and a wall-shaped protrusion spacer 603 is formed on the outside of the

display region. Fig. 27(a) is a cross-section view thereof. Fig. 27(c) illustrates the state that a mixture 32 of a liquid crystal and resin is filled in a region surrounded by the wall-shaped protrusion spacer 603 and ultraviolet rays or heat is applied. Fig. 27(d) illustrates the state that the liquid crystal and the resin are separated from each other. In the left side of Fig. 27(d), drops 33 of high molecular dispersion type liquid crystal are formed in the solidified resin 34. A liquid crystal layer 35 is formed at the lower side and a resin film 36 is formed at the upper side. This protrusion spacer forms the liquid crystal layer and the resin layer on the substrate.

[0435]

If necessary, an organic conductive film is formed on the upper substrate or is stuck with the substrate on which the other color liquid crystal layer is formed shown in Fig. 11. Also, in the latter case, a fine capsule a predetermined color particle 2 exists in the liquid crystal. The liquid crystal layer or the capsule is destroyed by heat, ultraviolet rays, or chemicals which are previously mixed in the liquid crystal, and particles such as the cyan, the magenta, and the yellow in the capsule is dispersed.

[0436]

Although the liquid crystal display device according to the present invention are illustrated based on several

embodiment, the present invention is not limited to these. That is, for example, the following structure is possible.

[0437]

1) A display device having a plurality of liquid crystal layers is a double matrix type, 3-division double matrix type, or projective liquid crystal display shown in Fig. 13. Further, there is a color filter of a plasma panel.

2) As the liquid crystal, E-8(BDH), or ZLI4792 (Mearch), or TL202(Mearch) is used, not E-7(BDH) of which permittivity anisotropy is positive. Also, ZLI4788 (Mearch) of which permittivity anisotropy is negative may be used. In this case, it is preferable that a vertical orientation film is used as the orientation film.

[0438]

3) Moreover, the liquid crystal is not limited to the nematic liquid crystal and various liquid crystals such as ferroelectric liquid crystal or antiferroelectric liquid crystal may be used.

[0439]

As the orientation film, the other material may be used.

[0440]

4) An active element, MIM (Metal-Insulator-Metal) of two-terminal element, a ZnO varistor, a SiN_x diode, or an a-Si diode is used, not the TFT of 3-terminal element. Also, a TN or STN without the active element can be applied.

[0441]

5) A planarization film such as polyimide is formed on SiN_x.

[0442]

6) A liquid crystal mode uses a vertically alignment method or in-plane switching method.

[0443]

7) The pixel is used as a reflecting panel by forming metal such as Al, not ITO.

[0444]

8) One side or the both side of the substrate is formed with a film or plastic.

[0445]

9) As the opposite substrate, a substrate having a color filter or a substrate having a color filter formed on an array substrate is used, not the glass substrate having the ITO. Also, in this case, the protrusion is formed on the array substrate, the opposite substrate, or the both substrates.

[0446]

10} As the spherical or fiber resin which is used for the spacer of the seal part, oxide-denaturalized polyethylene or pet of polypropylene is used.

[0447]

Also, as the seal resin, nylon resin or fluoric resin

may be employed.

[0448]

11) As the pixel or the semiconductor for driving element, the other material except for the polysilicon is used.

[0449]

12) Since the protrusion is formed according to the black matrix of the color filter or is formed instead of the black matrix, the notch is formed for convenience of the liquid crystal injection. However, the protrusion is formed in a grid shape.

[0450]

Also, in case of multiple liquid crystal layers, the liquid crystal layer is formed in a grid shape at the boundary between the pixels.

[0451]

13) As the protrusion, PC403, PC335, PC339H, JNPC-43 (JSR) may be used, not HRC-126.

[0452]

14) By forming the rod-shaped protrusion shown in Fig. 7 by 90%, the excessive rigidity of the panel is removed and the other function such as arrangement of the liquid crystal molecules is accomplished.

[0453]

15) In the shape of the protrusion, the diameter

thereof is smaller than the height thereof depending on the other condition or usage.

[0454]

16) As the method for forming the color filter, a printing method, an inkjet method, an electro-deposition method, or a dyeing method may be used, not the photolithography or pigment dispersion method.

[0455]

17) The protrusion may be formed using a printing method or an inkjet method.

[0456]

18) Figs. 28 and 29 illustrate a case that a plasma address liquid crystal display (PALC) employs the present invention. This is obtained by combining the plasma and the liquid crystal. The liquid crystal is driven using the plasma as a switching element.

[0457]

In Fig. 28, 501 is a plasma glass substrate. 502 is a Ni electrode. 503 is a rib. 504 is a thin plate glass. 505 is a flit. 506 is a protrusion spacer. 507 is a liquid seal material. 508 is a liquid crystal layer. 509 is a front plate.

[0458]

In Fig. 29, 701 is a backlight. 702 is a cathode. 703 is an anode. 704 is a polarization plate. 705 is a back

plate. 706 is a partition wall. 707 is an insulating plate. 708 is a liquid crystal layer. 709 is a front plate. 710 is a polarization plate. 711 is a stripe-shaped color filter. 712 is a transparent electrode consisting of ITO. Also, various modifications are possible. That is, the front plate may be a color filter.

[0459]

The PALC is obtained by replacing a TFT array part of a TFT-LCD with a plasma channel. The detailed principle or operation is disclosed in "monthly publication LCD Intelligence 1997, Second". Accordingly, their description will be omitted.

[0460]

In any cases, a protrusion space may be employed in the seal part of the liquid crystal or gas.

[0461]

[Advantages]

As mentioned above, according to the present invention, since a spacer which is made of soft resin is used for maintaining the substrate interval of the liquid crystal seal part which is provided in the driving circuit part adjacent to the display region of the liquid crystal panel, the spacer does not destroy the adjacent driving circuits, although an excessive pressing force is applied upon sticking the substrates, particularly, upon curing the seal

resin.

[0462]

Furthermore, since the spherical resin spacer is used for regularly maintaining the substrate interval in the seal part formed on the driving circuit part, the spacer does not destroy the adjacent driving circuits, although an excessive pressing force is applied upon sticking the substrates, particularly, upon curing the seal resin. In this case, since the spacer has the spherical shape, the spacer can not overlap. Also, although the spacer is mixed in the seal resin, any problem is not caused.

[0463]

Moreover, since the elastic protrusion for regularly maintaining the substrate interval in the seal part formed on the driving circuit part is not formed in the portion which is apt to be damaged, the spacer does not destroy the adjacent driving circuits, although an excessive pressing force is applied upon sticking the substrates, particularly, upon curing the seal resin. Also, the panel can be suppressed from being damaged by applying the excessive pressing force due to the error of a manufacturer.

[0464]

Further, since the protrusion for regularly maintaining the substrate interval is not formed in the pixel part in the display region of the liquid crystal panel, the

orientation of the liquid crystal molecules are not scattered or the non-transmittance of the light is not generated. Accordingly, good display is accomplished. In this case, since the spacer is not formed in the pixel part of the display region, the orientation is not scattered by the spacer or the light is not diffused. Accordingly, good display is obtained.

[0465]

Particularly, in the panel having the plurality of the liquid crystal layers for color display, this effect increases. In this case, the difference of the thickness of the resin layer can be easily solved.

[0466]

Also, a process of dispersing the spherical spacers is not required.

[0467]

Also, in this case, it can be used for the electrical connection between the layers of the substrate.

[0468]

Also, by forming the protrusions of the display region and the seal part by one process, the process number and the material quantity are reduced.

[0469]

Also, by providing the rod-shaped protrusion in the pixel, the arrangement of the liquid crystal molecules can

be controlled and the viewing angle characteristic and the response can be improved.

[0470]

Since the forming density can be easily changed in the seal part and the display part, the rigidity of the panel and the display characteristic of the display device are excellent.

[0471]

Moreover, since the thickness of the liquid crystal layer is controlled with high precision and thus the liquid crystal can be protected in a high molecular dispersion or a liquid crystal and resin mixing liquid crystal display device, this liquid crystal display device is cheap and has high performance.

[0472]

Further, a small-sized liquid crystal display device having high performance and high reliability can be provided using polysilicon.

[0473]

Moreover, although polysilicon is not employed, a liquid crystal panel having good display quality can be obtained.

[0474]

The present invention can be applied to a display using the liquid crystal, for example, an image projective display,

a color filter of a plasma display, or a front glass. In this case, the same effect as the above-mentioned liquid crystal display device is obtained.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a plan view of a small-sized liquid crystal panel having a driving circuit at the periphery of a display region on a substrate and a seal of a liquid crystal formed on the driving circuit and employing polysilicon which is recently developed and used.

[Fig. 2]

Fig. 2 illustrates an example of the structure of the seal part and the schematic principle of a liquid crystal display device without a color filter.

[Fig. 3]

Fig. 3 is a cross-sectional view of a main part of a liquid crystal panel according to a first embodiment of the present invention.

[Fig. 4]

Fig. 4 illustrates a relationship between a load (press force) and a (contraction) deformation amount applied to spherical spacers employed in the first embodiment.

[Fig. 5]

Fig. 5 is a cross-sectional view of a main part of a liquid crystal panel according to a second embodiment of the

present invention.

[Fig. 6]

Fig. 6 is a cross-sectional view of a liquid crystal panel according to a third embodiment.

[Fig. 7]

Fig. 7 is a cross-sectional view of a liquid crystal panel according to a fourth embodiment.

[Fig. 8]

Fig. 8 is a cross-sectional view and a plan view of a main part of a liquid crystal panel according to a fifth embodiment.

[Fig. 9]

Fig. 9 is a cross-sectional view of a main part of a liquid crystal panel according to a sixth embodiment of the present invention.

[Fig. 10]

Fig. 10 illustrates cross-sectional structure of an end of a liquid crystal panel according to a seventh embodiment of the present invention.

[Fig. 11]

Fig. 11 illustrates cross-sectional structure of an end of a liquid crystal panel according to an eighth embodiment of the present invention.

[Fig. 12]

Fig. 12 illustrates cross-sectional structure of an end

of a liquid crystal panel according to ninth and tenth embodiments of the present invention.

[Fig. 13]

Fig. 13 illustrates the structure of various double matrix type panels having a plurality of liquid crystal layers.

[Fig. 14]

Fig. 14 is a plan view of a liquid crystal panel according to an eleventh embodiment of the present invention.

[Fig. 15]

Fig. 15 illustrates the structure of a main part of the liquid crystal panel of the above-mentioned embodiment.

[Fig. 16]

Fig. 16 illustrates the structure of a liquid crystal panel using spherical liquid crystal spacers which is manufactured so as to be compared with the above-mentioned embodiment.

[Fig. 17]

Fig. 17 illustrates the structure of a main part of a liquid crystal panel of a twelfth embodiment according to the present invention.

[Fig. 18]

Fig. 18 schematically illustrates the injection state in prior art and the liquid crystal injection to a liquid crystal panel according to a fifteenth embodiment of the

present invention.

[Fig. 19]

Fig. 19 illustrates the structure of a main part of a liquid crystal panel according to a seventeenth embodiment of the present invention.

[Fig. 20]

Fig. 20 illustrates the structure of a main part of a liquid crystal panel according to a seventeenth embodiment of the present invention.

[Fig. 21]

Fig. 21 illustrates the structure of a main part of a liquid crystal panel according to a nineteenth embodiment of the present invention.

[Fig. 22]

Fig. 22 illustrates the structure of a main part of a liquid crystal panel of according to a twenty-first embodiment of the present invention.

[Fig. 23]

Fig. 23 illustrates the structure of a seal part of the liquid crystal panel of the above-mentioned embodiment.

[Fig. 24]

Fig. 24 illustrates the structure of a main part of a liquid crystal panel of according to a twenty-third embodiment of the present invention.

[Fig. 25]

Fig. 25 illustrates a modification example of the liquid crystal panel of the above-mentioned embodiment.

[Fig. 26]

Fig. 26 illustrates the structure of a main part of a liquid crystal panel of according to a twenty-fourth embodiment of the present invention.

[Fig. 27]

Fig. 27 illustrates a method for manufacturing a liquid crystal panel of according to a twenty-fifth embodiment of the present invention.

[Fig. 28]

Fig. 28 illustrates a method for manufacturing a PALC employing the present invention.

[Fig. 29]

Fig. 29 illustrates the structure of a main part of the PALC.

[Reference Numerals]

101, 102: glass substrate

201, 202: electrode

211, 212: combination of substrate and electrode

213, 214: combination of substrate and electrode

221-224: peripheral driving circuit part for each color pixel

3: liquid crystal

303-304: liquid crystal layer liquid crystal filter

for each color

31: arranged liquid crystal molecules

32: liquid crystal (precursor and resin)

33: liquid crystal particle drop

34: matrix resin

35: liquid crystal layer

36: resin film

4: orientation film

5, 50, 51-58: seal resin (seal part)

6, 61-67: resin protrusion in seal resin

60: resin protrusion in display region

601: resin protrusion in display region

603: wall-shaped resin protrusion

604: wall-shaped resin protrusion spacer

605: wall-shaped resin protrusion spacer

7: spherical resin spacer in seal part

71: spherical resin spacer in display region

8: protrusion

9: conductive paste

10: source

110: image (source) signal line

11: drain

111: scan (gate) signal line

12: gate

13: insulating film (SiO_2)

14: semiconductor layer

15: insulating film (SiN_x)

153: planarization layer

154: height controlling film

155, 156: color filter, black matrix

16: polarizer

17: pixel element

18: seal pure resin layer

19: glass fiber piece

20: display region part

21: peripheral driving circuit part (gate)

22: peripheral driving circuit part (source)

30: sealing (injection) part

40: light

80: dropped liquid crystal

91-94: connection part

95: wiring

501: plasma glass substrate

502: Ni electrode

503: rib

504: thin plate glass

505: flit

506: protrusion spacer

507: liquid crystal seal material

508: liquid crystal

59: front plate

701: backlight

702: cathode

703: anode

704, 710: polarization layer

705: back plate

706: partition wall

707: insulating plate

708: liquid crystal

709: front plate

711: color filter